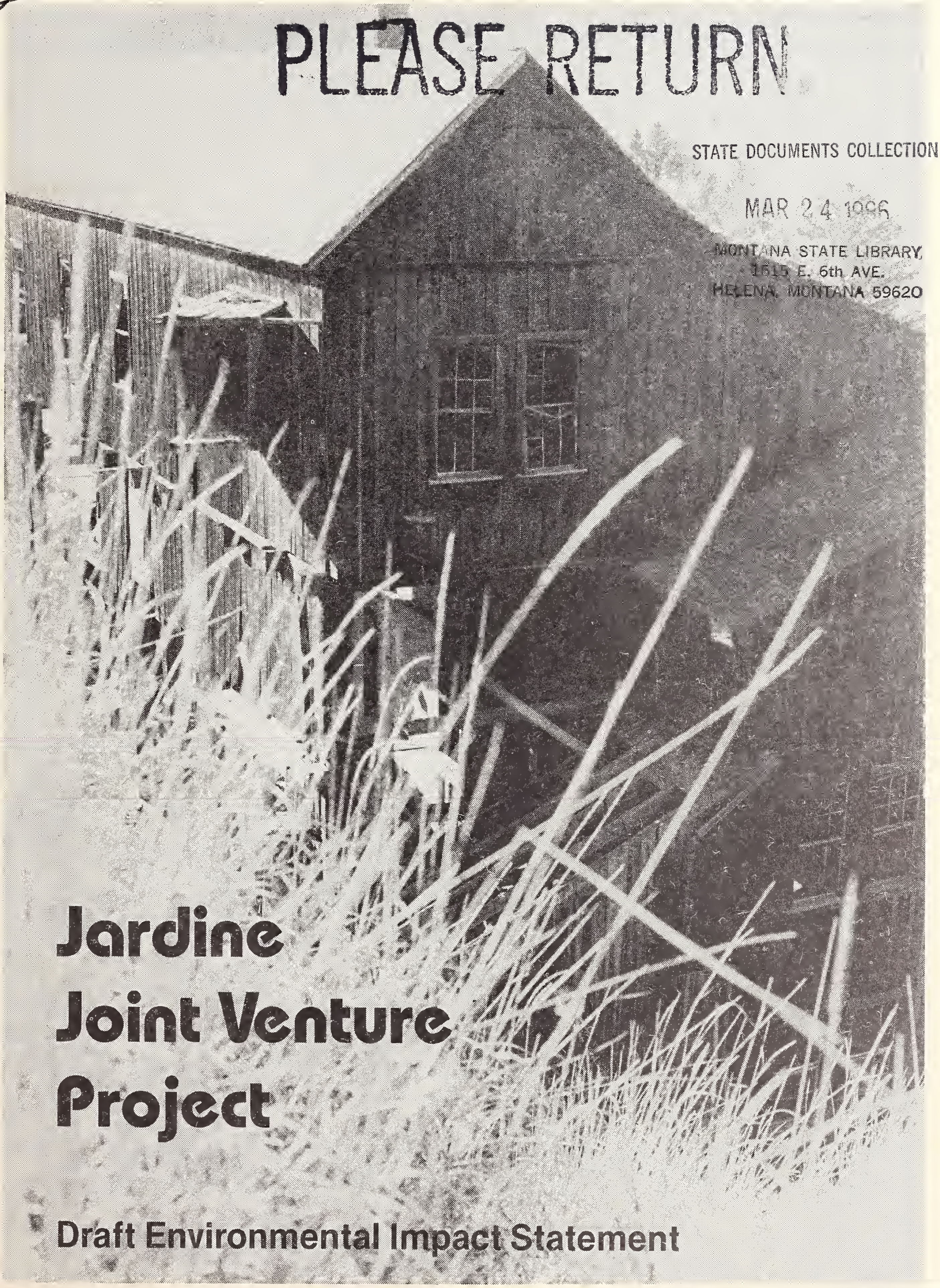

Jardine Joint Venture Project

Draft Environmental Impact Statement

Montana Department of State Lands

U.S.D.A. Forest Service

DEPARTMENT OF STATE LANDS

TED SCHWINDEN, GOVERNOR

STATE OF MONTANA

(406) 444-2074

1625 11TH AVENUE
HELENA, MONTANA 59620

October 24, 1985

Dear Reader:

Enclosed for your review is a draft environmental impact statement (EIS) for the Jardine Joint Venture mining project proposed by Homestake Mining Company and the American Copper and Nickel Company (ACNC). The document analyzes the environmental impacts of the Joint Venture's plans to build a new mill and underground mine on Mineral Hill above Jardine in Park County, Montana.

The Montana Department of State Lands and U.S. Forest Service would like your comments.

Mailed comments must be postmarked by December 16, 1985. If comment or new information require major changes in the analysis, a final EIS will be issued before a decision is made on the proposed mining and reclamation plan. The final EIS may incorporate portions of the draft EIS by reference, so please retain this copy for later use.

Send your comments to the attention of Mr. Kit Walther, Chief, Environmental Analysis Bureau, Montana Department of State Lands, Capitol Station, Helena, Montana 59620.

A public hearing will be held on Tuesday, December 3, 1985 at 7:00 p.m. in the Gardiner High School Multi-Purpose Room, Gardiner, Montana.

Additional information on the Jardine Joint Venture application is available from the Department's Helena office, the U.S. Forest Service, Supervisor's Office in Bozeman, and the Gardiner District Ranger's Office in Gardiner.

Sherm Sollid

Sherm Sollid
Geologist
Gallatin National Forest
U.S. Forest Service

Kit Walther

Kit Walther, Chief
Environmental Analysis Bureau
Reclamation Division
Montana Department of State Lands

Draft

Environmental Impact Statement

September 1985

Montana Department of State Lands

Dennis Hemmer, Commissioner

U.S. Forest Service
Gallatin National Forest

Robert E. Breazeale, Supervisor

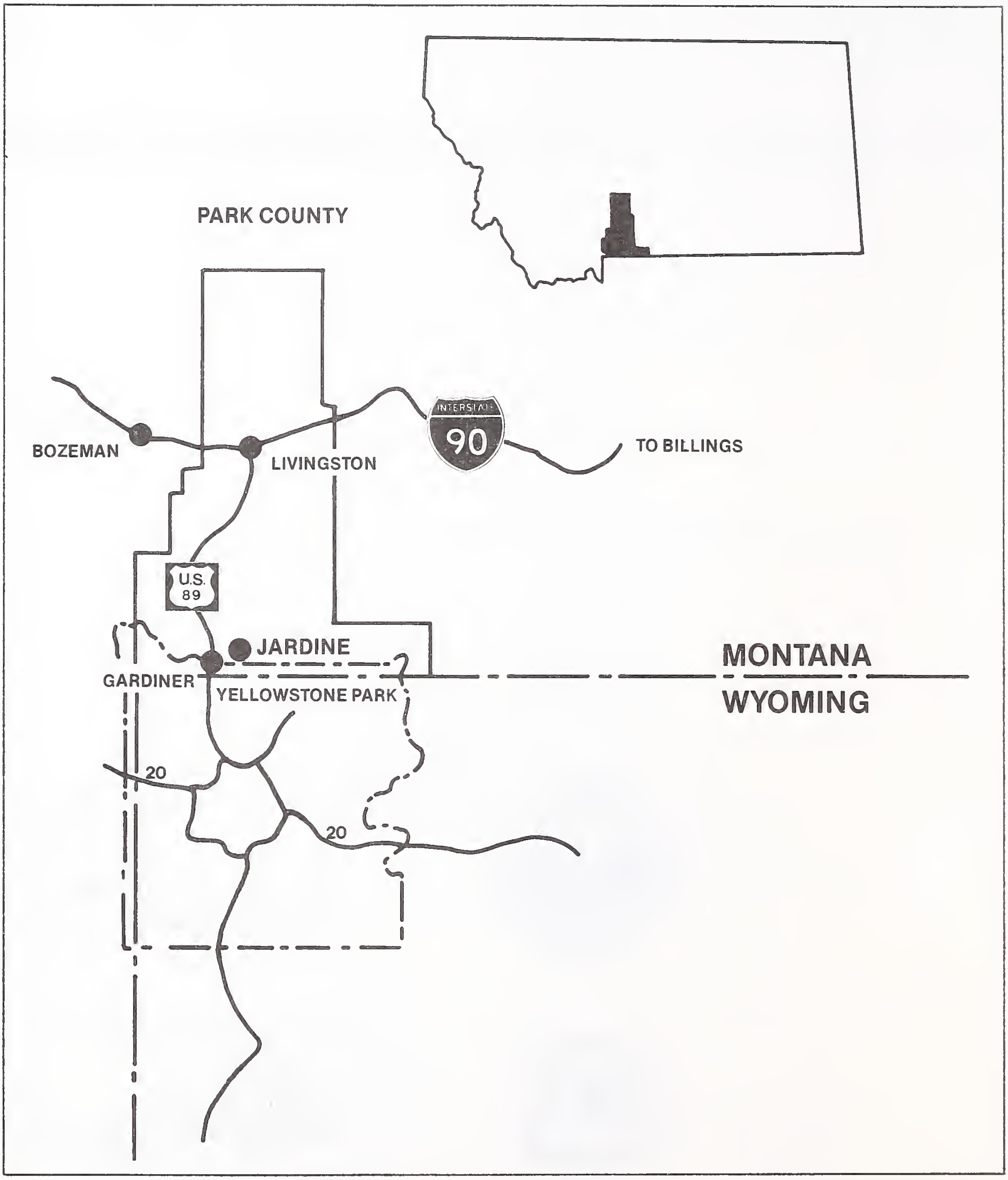

Figure S-1: The applicant proposes to mine for gold at Jardine, Montana, located 3 air miles north of Yellowstone National Park.

SUMMARY

The Homestake Mining Company (HMC) and the American Copper and Nickel Company (ACNC) have filed joint venture plans with the Montana Department of State Lands (DSL) and the U.S. Forest Service to build a new mill and underground gold mine, known as the Jardine Joint Venture (JJV) Project, on the west side of Mineral Hill above Jardine, Montana (figure S-1). The two regulating agencies must decide whether to approve the permit as applied for, approve the permit with modified mining or reclamation plans, approve the permit subject to stipulations, or deny the permit. (The Homestake and ACNC joint venture proposal is referred to in this EIS as the applicant's proposal.)

THE APPLICANT'S PROPOSAL

During full operation, the mine would extract 1,050 tons of ore per day five days per week. The mill would process the ore into gold concentrate and refine the concentrate with a cyanide process. The mill waste, or tailings slurry, would be piped to either a sealed tailings impoundment or back into the mine. A total of about 450 tons of filtered tailings would be discarded 7 days per week in the impoundment. About 300 tons per day would be dumped in the empty mine cavities. The water would be removed from the slurry and returned to the mill.

In building the project, the applicant would establish an 18-acre facilities complex. Over the next 20 years, miners would drill and blast about seven miles of new underground workings.

The project would employ 150 people; 75 would work in the mine, 25 in the mill, and the rest in administration and maintenance. The applicant expects to hire 120 workers locally.

AREAS OF CONTROVERSY

The Department of State Lands and the U.S. Forest Service identified issues and concerns related to the applicant's project. The two agencies, in conjunction with the applicant, held a public meeting on November 14, 1984, in order to gather comments on the project from citizens. Areas of controversy include wildlife, air and water quality, and socioeconomic impacts. These and other concerns are discussed in the introduction.

PREFERRED ALTERNATIVES

The agencies have analyzed proposed alternatives to the applicant's project plan. The alternatives included

1) county access roads from Gardiner to the mine,
2) tailings dump sites, and
3) mine-access roads.

Among the alternatives considered, all except one mine-access road alternative and one county road alternative were eliminated for various reasons. The alternatives that were dismissed are discussed in Chapter I.

For the county road, either Alternative A or the applicant's proposal (with the stipulation of bussing employees between Gardiner and the project site) is preferred to the applicant's proposal. For the mine-access road, the regulating agencies prefer Alternative 1 to the proposal. The agencies' preferred county road and mine-access road alternatives are compared in Chapter IV.

SUMMARY OF IMPACTS BY DISCIPLINE

Geology. The tailings dump would be very stable during the operation of the mine and for centuries to follow. Excessive erosion and gullying could occur in the diversion ditch alongside the tailings dump during a 100-year flood event.

Hydrology. The maximum quantity of water required by the project would be about 47,130 gallons per day, or 0.073 cubic feet per second. This quantity of water would be withdrawn from Bear Creek and would deplete the stream by a factor of 0.5 percent during periods of low flow. This depletion could potentially impact the amount of water available to maintain minimum instream flows depending on the outcome of the present adjudication process.

Soil erosion and sediment loading to Bear Creek are predicted to increase during construction and approach baseline levels by year three. Actual concentrations of total suspended sediment in Bear Creek would depend largely on prevailing weather conditions.

Sewage generated by the project would be treated by a septic-tank drainfield system located 100 feet from Bear Creek. A small increase in the concentration of total nitrogen would be expected in Bear Creek below the drainfield site.

Two historic tailings impoundments would be removed and placed within the proposed tailings dump. This action would result in a decrease in the loading of cyanide, arsenic, and other heavy metals to the ground water system and Bear Creek.

Aquatics. Increases in total suspended sediment (TSS) and total nitrogen in Bear Creek would have little effect on aquatic insect and algal communities. Changes, if any, would be temporary, and recovery would be rapid.

Fisheries. The concentrations of total suspended solids (TSS) and total nitrogen in Bear Creek are predicted to increase as a result of mining activities (see Chapter III--Hydrology). However, these increases would be insignificant and are not expected to adversely affect the fishery.

Soils. Biological impacts would occur in soils stored for prolonged periods. These impacts include a reduction or loss of soil microorganisms important to plant growth and nutrient cycling, a breakdown of soil structure, a reduction in organic matter, a loss of soil nutrients, and a loss of native seeds and other potentially active vegetative parts. Until vegetation is established, soil erosion would be moderate on the steep waste rock dump slopes, and minimal in other disturbance areas. Plant toxicity problems due to the chemical characteristics of soils or underlying waste materials are not expected.

Vegetation. Mining would destroy 67 acres of native vegetation and 26 acres of previously disturbed land. The tailings dump, tailings sites from previous mining, and stored topsoil would be revegetated while the mine operates. With few exceptions, seeded grasses and forbs would establish an erosion-controlling ground cover. Douglas-fir would slowly invade the waste rock dumps, road and slurry line corridors, and edges of the tailings dumps. Planted Douglas-fir seedlings would also grow on the waste rock dumps. Several decades would be required for newly established Douglas-fir to reach premining heights. Problems that may be encountered during revegetation include introduction of weeds, occasional erosion on steep slopes, and damage to developing plants by wildlife and blowing tailings.

Wildlife. Along with previously developed land, mining would remove 67 acres of wildlife habitat. Displaced wildlife would find adequate habitat nearby and reclaimed land would eventually provide suitable habitat. Elk and deer would initially avoid mining activity, but may, after habituation, move to habitats near the permit area. Significant disruptions of elk migrations are not expected. Mine-related traffic would increase road kills and may conflict with other vehicles during the late-season elk hunt. Increases in poaching and antler-collecting, combined with existing levels of these activities, would be detrimental to wintering big game animals. Proposed logging could combine with mining to negatively affect elk.

Threatened and Endangered Species. Mining would remove 67 acres of spring habitat used by foraging grizzly bears. The grizzlies would respond to habitat loss by moving into nearby, suitable habitats. After mine closure, revegetated lands would supply adequate foraging areas. Human activity would initially displace grizzlies from the vicinity of the permit area; however, some grizzlies would become accustomed to human activity and may forage near the mine, increasing the chances for encounters between grizzlies and humans. Human/grizzly conflict could lead to management actions that may include relocation or destruction of some grizzlies. The number of conflicts and outcomes of management actions cannot be predicted.

Road-killed wildlife would attract bald eagles and grizzly bears, raising their chances of being struck by vehicles. Population growth (with or without the mine) would increase recreational use of the area, which would in turn increase conflicts between grizzlies and humans. Opportunities to poach grizzlies and bald eagles would increase as the human population rises.

Logging could increase impacts on grizzlies; however, specific impacts or their severity cannot be predicted until Forest Service management actions are specified.

Air Quality. With proper control, the predicted dust emissions would not adversely affect the air quality near Jardine. The estimated total suspended particulate (TSP) concentrations occurring during the operation would probably be well below all applicable Montana Ambient Air Quality Standards (MAAQS).

Income. Mine employment would add $3.4 million annually to Park County income once the mine is at full employment. Secondary job increases would add between $359,936 to $506,160 to total county income.

Employment. The project would add 140 new jobs to the Park County economy. An additional 32 to 45 jobs would be created due to increased income and spending from new mining jobs.

After permanent closure of the mine, employment would decline to what it would have been without the mine. Temporary closures may cause service sector businesses to lay off other employees, if the closure lasts long enough.

In the cumulative scenario, logging would add about five seasonal jobs from 1987 to 1996. These positions may be filled by Park County residents.

Sociology. Demography--The proposed project is expected to employ about 50 workers during the initial construction period and first phase of the mine operation (1986 and 1987). Beginning in 1988, the mine is scheduled for full-time operation and, at that point, the mine and mill would employ about 150 people. Given the added need for services and the available income due to the mine and mill, secondary employment in the county would increase by about 45 persons by 1991.

Social Life--Residents in the Gardiner area vary both in their perceptions of how the project may affect the area and in the importance they ascribe to these changes. Some residents of the Gardiner area may consider the quality of their lives diminished because of changes that could result from mining activity or from the increased population accompanying the project. The increased population; additional traffic, especially during construction; increased noise at the minesite from mine/mill construction and operation; impacts to the physical environment; and potential social conflict could cause people to perceive changes in the characteristics of the area they value most. Residents may perceive a deterioration in the quality of the natural environment; a faster pace of life; less friendliness among residents; or a reduction in the quiet, solitude, and privacy presently enjoyed in the area.

Community Services--Impacts to community services that would occur because of the proposed mining project are associated with increased migration into the area. Workers and their families would move in, establish residences, and exert an increased demand on community services. Predicting the impact of this increased demand, however, depends on knowing the exact numbers of newcomers and where they would settle.

Fiscal. The JJV project would increase tax revenues for Park County, both school districts in Gardiner, special service districts in Gardiner, and the state of Montana. Over the life of the project, and at current gold prices ($316.47 per ounce), the applicant would add between $986,000 and $2.6 million to the annual tax base of the Park County and both Gardiner school districts. The service districts in Gardiner would receive between $634 and $4,320 dollars in increased revenues at current rates for services, assuming that incoming workers build 15 new homes within the service district boundaries. The state would receive $301,570 annually from the mine at current gold prices.

Land Use. Land use would not change substantially in Park County due to the project. Reclamation of surface disturbance within the permit area would be planned so as to establish suitable wildlife habitat and livestock grazing land after mine closure (see Chapter III--Vegetation). Within Park County, up to 19 acres of agricultural land could be converted to residential uses if incoming mine workers chose to construct new homes.

Transportation. The mine and mill would cause significant increases in average daily traffic (ADT) levels on the Jardine Road, but only moderate increases on U.S. 89. During the first year of full-employment operation, traffic would increase 50 to 70 percent on the Jardine Road, and about 12 percent on U.S. 89. Accidents would increase by almost one-fourth on U.S. 89.

Cumulative impacts on the Jardine Road and U.S. 89 due to proposed timber sales would be negligible.

Recreation. The project would have little direct impact on National Forest land.

Cultural Resources. This project would cause 21 structures in the proposed Jardine Historical District to be removed. Figure II-28 details the existing structures in Jardine. Three of these structures are considered significant historic buildings, although they are in poor condition.

Aesthetics. Although the Jardine area has been disturbed by previous mining, the applicant's project would be highly visible to local residents and visitors traveling to Jardine and upstream Bear Creek. The milling building, crushing facilities, and tailings pond would be the most evident features.

Due to surrounding hills, the operation would only be visible from within 1.2 miles when approaching Jardine on the county road. The operation would also be visible in the background from some areas of Yellowstone Park--Mammoth terraces and Yellowstone lodge, for example.

After mining is complete, all structures would be removed and all disturbed areas revegetated. The tailings impoundment would probably still be recognizable as differing from the surrounding landscape.

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INTRODUCTION

The Homestake Mining Company and the American Copper and Nickel Company (referred to here jointly as "the applicant") plan to build a new mill and underground gold mine, known as the Jardine Joint Venture project, on the west side of Mineral Hill above Jardine, Montana (figure IN-1). The Montana Department of State Lands (DSL) and the U.S. Forest Service have determined that the project may significantly affect the quality of the human environment. As a result, the two agencies are required to prepare an environmental impact statement (Montana Environmental Policy Act [MEPA], 1971, and National Environmental Policy Act [NEPA], 1969).

The National and Montana Environmental Policy Acts require the Forest Service and DSL to follow a detailed procedure that includes

--issuing a draft EIS,
--encouraging and accepting public comments on the draft, and
--issuing a final EIS. In accordance with rules adopted by DSL and the Environmental Quality Council regulations, the final EIS may--

(a) modify alternatives, including the proposed action,
(b) develop and evaluate alternatives not previously given serious consideration,
(c) supplement, improve, or modify the analysis contained in the draft,
(d) make factual corrections,
(e) respond to or explain why comments do not warrant further response.

The EIS analyzes (1) the applicant's proposal and alternatives, (2) the lands, people, and resources the proposal would affect, and (3) the consequences (or impacts) of the proposal and alternatives. The draft EIS does not present DSL's or the Forest Service's decision, but does present the alternatives the agencies prefer. The agencies will make a decision on the Jardine Joint Venture project proposal after publication of the final EIS. DSL can make a decision no sooner than 15 days following publication. The Forest Service can make a decision upon publication.

Issues and Concerns

The Department of State Lands (DSL) and the U.S. Forest Service have formally received comments at a public meeting in Gardiner on November 14, 1984, and in the form of 13 letters written in response to an agency information brochure. The concerns expressed in these comments, along with the concerns of DSL and the Forest Service, form the scope of this draft EIS analysis.

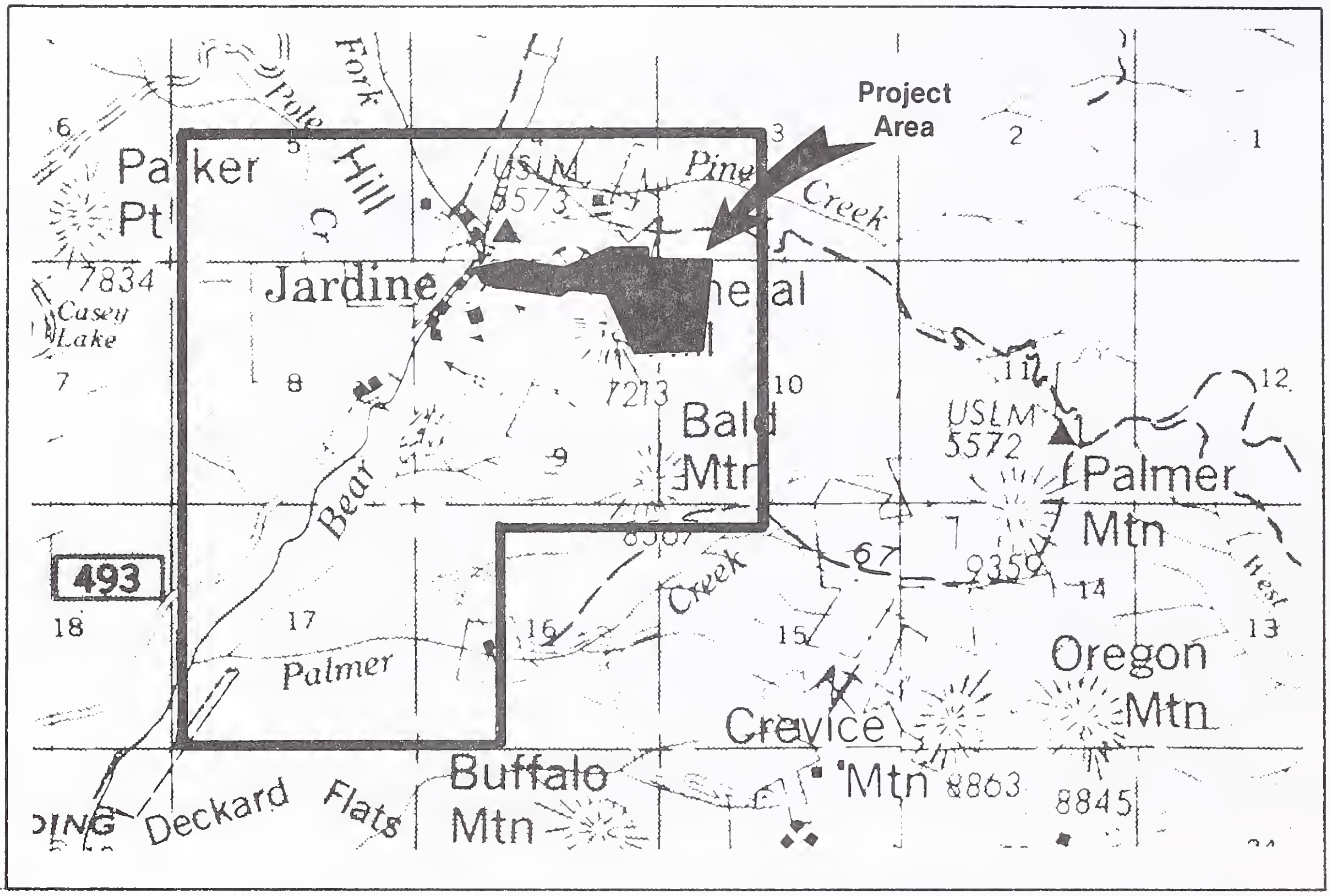


Figure In-1: Mining would occur on Mineral Hill, above Jardine.

Public concerns regarding the Jardine Joint Venture (JJV) Project include the following:

1) Noise level at Jardine: Construction; mine/mill operation; traffic.

2) Visual aesthetics: In Jardine, especially tailings and possible temporary housing; in Gardiner, temporary housing.

3) Wildlife: Potential increase in poaching; effect of hunter access to mining property or on mining roads; elk migration and winter range (reduction due to land trade); threat to grizzly bear habitat.

4) Air quality: Tailings dust; dust from non-tailings disturbed areas; dust from increased road traffic; increased woodburning for residential heat; effect of mill operation on air quality of nearby wilderness; need to comply with air quality standards for Class I areas.

5) Tailings: Location near Bear Creek potential for polluting the creek; need for lining the mine return slurry pipeline trench and tailings discharge pipeline trench; need to isolate storage of tailings from ground water in the mine; need to adjust tailings disposal system to weather; effect on area soils; size of tailings site.

6) Surface dumps and waste rock: Surface ground water discharge; chemical nature of dumps; location of dumps; reclamation of dumps.

7) Toxic materials: Need to isolate from the workforce and the environment.

8) Reclamation: Responsibilities after plant closure; need for continuous reclamation.

9) Water quality: Need for Montana Department of Health and Environmental Sciences surface water discharge permit; deterioration from rural housing development; deterioration of Bear Creek and Yellowstone River, specifically from tailings; potential for tailings spill.

10) Water rights: Mining company claim on Bear Creek questionable; impact to other users by reviving rights; effect of National Park Service water rights to Bear Creek.

11) Watershed: Threat to the Jardine-area watershed.

12) Transportation: Location of new road, if any; request for speed limit of 15 mph; increased traffic, especially on Jardine Road; potential for accidents, especially involving school children; need to improve Z Hill.

13) Population: Potential for secondary population response; potential for larger population increase in the Gardiner area if assumptions regarding commuting and local hire are not accurate.

14) Social values: Potential conflict between newcomers and current residents; potential union/non-union conflict.

15) Social structure: Addition of another separate social group to the Gardiner area; income disparity between mine workers and other Gardiner area residents.

16) Housing: Demand greater than supply in the Gardiner area; demand increase as workers choose not to commute.

17) Community services: Potential for reducing the quality of education in Gardiner schools; adequacy of community services in the Gardiner area, specifically law enforcement, sewer treatment, water supply and fire protection.

18) Employment: Assumption questionable of 80 percent local hire; secondary employment response.

19) Economic: Impact of reduced water quality, fisheries, and wildlife on area businesses; potential for decreased housing values in Jardine if water quality or aesthetics deteriorate; early or temporary plant closure effect on business and housing investment.

20) Cultural Resources: Fate of historic houses at Jardine.

21) Utilities: Need for new power line or corridor from Gardiner to Jardine, its possible location, and its effect on raptors.

22) Construction phase: Length of construction; party responsible for building the mill.

23) Possible connection between Jardine Joint Venture and outfitters (more competition for local outfitters).

24) Need to consider impacts in combination with other developments, specifically logging and West Gardiner access.

25) Potential for unmitigatable impact in arsenic-related process.

26) Greater Yellowstone Ecosystem: Threat to natural vegetation, wildlife, air, and water quality of Yellowstone National Park and National Forest lands; cumulative effect on ecosystem from gold mining, oil drilling, geothermal development, and Ski Yellowstone.

The benefits anticipated from the applicant's proposed project include:

1) year-round employment for local residents,
2) an increased tax base for Park County,
3) a more stable economy in the Gardiner area,
4) potential for reduction in social welfare needs in the Gardiner area.

PREVIOUS RESEARCH

Sources of Information

This draft EIS used many sources of information. The sources are listed under References Cited at the end of this publication. The key documents are described here in more detail.

The applicant submitted a detailed "plan of operations"--or application--for a mining permit to conduct the Jardine Joint Venture project. This document is the most important source used in compiling the draft EIS. Included in the application is an extensive compilation of baseline information for 16 separate disciplines. For those interested, the application is available for review at the Department of State Lands, Helena, the U.S. Forest Service offices in Bozeman, and at Park County's planning offices in Livingston.

The applicant hired Western Technology and Engineering, Inc. (Westech), of Helena, to conduct research studies into the specific disciplines that the proposed project would potentially affect. Much of the information in this draft EIS comes from Westech's reports, and the reports of its subcontractors.

A detailed report on the Jardine tailings disposal facility was prepared for the applicant by Steffen Robertson and Kirsten of Lakewood, Colorado.

Mountain International, Inc., of Helena, prepared the socioeconomic report for the Jardine project. This report covers topics such as employment, housing, and traffic conditions in the project area. It conforms to the Hard Rock Mitigation Impact Act (HB718 as amended), which requires developers to pay net increased operating and capital costs for local government due to hard rock mineral development.

METHODS AND STUDY AREAS

This brief description of the methods used in this EIS by the disciplines may help in understanding some of the topics discussed.

Geology

Two general study areas were used; one covers the greater Gardiner/Jardine area and is based on the U.S. Geological Survey report and map titled "Geology of the Gardiner Area, Park County, Montana." The other study area focuses on the mine/mill area at Jardine. The applicant provided detailed geologic maps and studies for the proposed tailings disposal and underground mine areas.

Hydrology

The surface water study includes analyses of water availability and water quality that focus on the main stem of Bear Creek between Pine Creek and the confluence with the Yellowstone River. Included is a discussion regarding the potential impact to the Yellowstone River. The ground water study evaluates the occurrence and movement of water in the alluvial aquifer in the vicinity of the existing and proposed tailings dump areas near the town of Jardine. The cumulative study area is limited to the Bear Creek drainage.

Soils

The applicant conducted a detailed (Order I) soil survey on about 2,500 acres in and around the town of Jardine. This area includes the 410-acre proposed permit area and the 93-acre proposed disturbance area.

Sociology

The social sciences study area included all of Park County with a more detailed emphasis on the Gardiner-Jardine area. Mammoth, Wyoming, and Livingston, Montana, were also included in the analyses for some social science topics. The areas north of Livingston in Park County were not studied due to the improbability of mine workers locating there.

The study methods used included a survey, interviews, literature review, analysis of relevant reports, and census and fiscal data. Consultants to the applicant used two computer models (WEDM and PUFMOD) to provide forecasts for local government expenditures, and county employment, income, and population.

Cultural Resources

During 1981 and 1982, an intensive cultural resource survey of about 3,100 acres was conducted (Steere, et al., 1982). The cultural resources on the project area were then reevaluated by Historical Research Associates (HRA). HRA prepared an impact assessment and management recommendations for all sites eligible for listing on the National Register of Historic Places (project application, 1984).

Vegetation

The vegetation study area includes and surrounds the proposed permit area. It is bound on the east by Mineral Hill and on the west by Parker Point. The southern part of the study area reaches almost to the lower limit of section 17 while the northern part roughly follows Bear Creek to the township division.

Wildlife

The proposed permit area is centered within the Jardine wildlife study area (figure II-10). The study area extends from the northern boundary of Yellowstone National Park, east to Crevice Creek, west to Little Trail Creek, and north to Monitor Peak. Along with the study area, a cumulative impacts analysis area was developed. This cumulative area included additional habitats that could be visited by elk or mule deer from the Jardine area. Therefore, the cumulative area was delineated by year-round elk and mule deer ranges found outside of Yellowstone National Park (figures II-11 and II-13).

Threatened and Endangered Species

The proposed permit is within the threatened and endangered species assessment area (figure II-16). The assessment area makes up the south-central portion of the Hellroaring/Bear (Creek) Bear Management Unit and includes Bear, Eagle, and Little Trail Creeks.

In addition to the applicant's proposal, the Forest Service has scheduled timber sales in the assessment area. Cumulative impacts of mining and logging are discussed in Chapter III--Threatened and Endangered Species.

Analyses were based on a biological evaluation that describes the ecology of threatened and endangered species in the project area and determines effects of the mine and other proposed projects. The evaluation was prepared by the U.S. Forest Service and will be reviewed by the U.S. Fish and Wildlife Service in accordance with Section 7 of the Federal Endangered Species Act of 1973.

AGENCY RESPONSIBILITIES

A number of agencies have or could have jurisdiction over the Jardine Project.

Montana Department of State Lands (DSL)

DSL administers the 1971 Montana Metal Mine Reclamation Act (also called the Hard Rock Mining Act), with which the applicant must comply. The purposes of the act are, first, to recognize and protect the usefulness, productivity and scenic values of the lands and waters within the state, and second, to reclaim to beneficial use the lands used for metal mines. The act and its regulations (ARM 26.4.101 et seq.) set forth the steps that must be taken in the issuance of an operating permit for, and the reclamation of, the proposed mine and mill. The act applies to all lands within Montana. Thus, DSL will regulate mining activity on both federal and private lands.

U.S. Forest Service

The Forest Service has authority to permit and regulate all operations and uses of national forest system lands.

The 1872 General Mining Law, as amended by the Multiple Surface Use Act (P.L. 167) of July 23, 1955, allows any prospector who discovers a valuable mineral deposit on national forest system lands open to mineral entry to locate and work on a mining claim. (See also 36 CFR 228.) At the same time, the Organic Administration Act of 1897 authorizes the Secretary of Agriculture to regulate occupancy and use of the national forests for the protection and management of national forest resources--this pertains to all national forest users, including prospectors and miners.

The Forest Service management policy for mining activity originates from the Mining and Mineral Policy Act of 1970, the National Materials and Minerals Policy, Research, and Development Act of 1980, and a number of executive (presidential) orders.

The "Locatable Mineral Regulations" (36 CFR 228) require a plan of operations to be submitted to the U.S. Forest Service for approval. Review and approval of the engineering report, and plans and specifications for the tailings dam are subject to Forest Service (manual 7500) requirements.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service administers the Endangered Species Act, as reauthorized in 1982, and the Bald Eagle Protection Act of 1940 (as amended). Federal agencies (in this case, the U.S. Forest Service) involved in actions potentially affecting threatened or endangered species must prepare a biological assessment to comply with the Endangered Species Act. If the

assessment determines that impacts would adversely affect threatened and endangered species, the preparing agency consults with the Fish and Wildlife Service to design measures to protect the affected species. A biological evaluation on grizzly bear, bald eagles, gray wolves, and peregrine falcons is being prepared by the Forest Service. The U.S. Fish and Wildlife Service will then review the assessment.

State Historic Preservation Office

The State Historic Preservation Office has the responsibility to cooperate with and advise DSL and the Forest Service when potentially significant historical, archaeological, or other cultural resources are located in a project area (Montana Antiquities Act [MCA 22-3-401 through 22-3-441], and the National Historic Preservation Act [P.L. 89-665 as amended and reauthorized E.O. 11593]). Part of the advice given to DSL may include comments on a company's plan for impact mitigation of sites eligible for nomination to the National Register of Historic Places. The office also reviews the EIS to ensure compliance with cultural resource regulations.

Under the Montana Antiquities Act, the State Historic Preservation Office is responsible for issuing antiquities permits for projects on state-owned lands. Under the National Historic Preservation Act, the office seeks determinations from the Keeper of the National Register for sites believed to be eligible for listing on the National Register of Historic Places. During mine operation, DSL monitors compliance with historic preservation and monitoring plans.

Montana Department of Health and Environmental Sciences

The applicant must apply for an air quality permit from the Air Quality Bureau of the Department of Health and Environmental Sciences (DHES). The permit would cover the mine, mill, and tailings sites, and would include all sources of emissions on the proposed permit area. The chief pollutant considered would be dust (particulate matter). Calculated levels must be within Montana ambient air quality standards before a permit can be issued.

The applicant must obtain from DHES's Water Quality Bureau a Montana Pollutant Discharge Elimination System (MPDES) permit, which would be required before waters from the mine facilities could be discharged to state surface or ground waters.

The applicant must construct and operate the proposed tailings pond to prevent water discharge, seepage, drainage, infiltration, or flow that may pollute surface or ground waters. The company must submit complete plans and specifications of the tailings pond to DHES no less than 180 days before initial construction.

Hard Rock Mining Impact Board

The Hard Rock Mining Impact Board (Hard Rock Board) created by the passage of House Bill 718 in 1980 is attached to the Montana Department of

Commerce for administrative purposes. It is a quasi-judicial board intended to act as "referee" in hearing disputes between local government units and large-scale mineral developers over the impact mitigation plan prepared by the developer. In the impact mitigation plan, the developer identifies the increased public sector costs associated with major mineral development and commits to pay, according to a specified time schedule, all increased capital and net operating cost to local government units that will be a result of the development.

The review of the impact plan by the Hard Rock Board is intended to occur concurrently with the procedure for fulfilling the operating permit requirements. If disagreement occurs between Park County or any affected unit of local government and the proponent, the disagreeing party can file an objection with the Hard-Rock Board.

An operating permit issued by DSL for a large-scale mineral development would be conditioned to provide that mining may not begin until the Hard Rock Board approves the impact plan and until the permittee has provided a written guarantee to DSL and to the Hard-Rock Board of compliance within the time schedule with the commitment made in the impact plan approved by the Hard Rock Board. If the permittee does not comply with that commitment within the time scheduled, DSL, upon receipt of written notice from the Hard Rock Board, will suspend the permit until it receives written notice from the Hard Rock Board that the permittee is in compliance.

Army Corps of Engineers

The Corps of Engineers would require a 404 permit if any bridges are replaced or strengthened in a manner that would put fill in any river. Need for a 404 permit is not anticipated at this time.

Local Conservation District

Similarly, bridge construction plans would require approval by the local conservation district if the company were planning to alter streambanks.

ADMINISTRATIVE PROCESS

After evaluation of this EIS, both DSL and the Forest Service have a number of options.

Montana Department of State Lands

DSL must take one of five administrative actions: (1) approve the permit as proposed, (2) take no action, (3) deny the permit, (4) approve the permit with modified mining or reclamation plans, and (5) approve the permit subject to stipulations.

1. Approve the permit as proposed

If DSL finds the applicant's proposal environmentally acceptable and requires no changes, it could approve the plans as proposed with no changes.

2. Take no action

If DSL were to take no action on the company's permit, the permit could be approved by default (82-4-337 Montana Codes Annotated [MCA]).

3. Deny the permit

DSL may deny the permit if the mining or reclamation plans violate the laws administered by DSL or the water and air quality laws administered by the Department of Health and Environmental Sciences.

4. Approve the permit with modified mining or reclamation plans

If the proposed plan were unacceptable, DSL could return it with a request that the company submit a modified plan. If, for example, DSL selected an alternative different from the applicant's proposal, DSL would require the company to submit new project plans.

5. Approve the permit subject to stipulations

If parts of the proposed plan were considered unacceptable, DSL could grant the permit with stipulations. Possible stipulations would include any modifications or additions to the proposed plans that the Commissioner considered necessary to meet the requirements of state laws. Possible stipulations are listed in Chapter III at the ends of most impact discussions.

U.S. Forest Service

Four administrative actions, some of which differ from those available to DSL, would be considered by the U.S. Forest Service: (1) no action, (2) approve the plan of operations as submitted, (3) approve a revised plan of operations with changes incorporated, and (4) approve parts of the plan that are acceptable; defer decisions on other portions of the plan.

1. No action

Under this action, the proposed plan of operations would be denied and, theoretically, no mining could take place; however, this alternative is not valid because under the 1872 mining law the national forest lands on which the project would occur are open to mineral location and entry. Consequently, the Forest Service cannot take "no action" if the applicant meets legal and policy requirements and takes reasonable measures to protect surface resources and public safety.

2. Approve the plan of operations as submitted

If the Forest Service agrees that the plan of operations is complete and adequate as submitted and no changes are required, the Forest Service would approve it.

3. Approve a revised plan of operations with changes incorporated

If the plan of operations as proposed is considered generally acceptable but in need of some revisions, the Forest Service could require changes. These changes would be for management and protection of the surface resources of national forest system lands or public safety.

This administrative action would be selected if the Forest Service chooses to require an alternative different from the company's proposal or to require any of the mitigating measures recommended in the EIS. If the Forest Service does select an alternative different from the applicant's proposal, the applicant would be required to submit modified mining plans.

4. Approve parts of the plan of operations

The Forest Service could approve part of the plan of operations and defer decisions on other parts of the proposal until further design data or specific information is available. The Forest Service would take action on these aspects of the proposal based on the degree to which they meet the objectives of reasonable environmental protection.

SCOPE OF ANALYSIS

The analysis in the foregoing chapters addresses the consequences of the agencies' courses of action (administrative alternatives).

The consequences of permit denial (an alternative of DSL, but not of the Forest Service) would be the same as described in Chapter II. That is, the existing conditions would continue as described and forecast in Chapter II. Chapter V is a synopsis of the effects a denial would impose on the area.

The no-action alternative, although not valid for either agency, would result in consequences described in Chapter III--Impacts of the Proposed Project. Mitigating measures to reduce environmental impacts of the project, however, could not be required because the agencies would not exercise their authorities under this alternative.

Similarly, the consequences of "approval of the plan as submitted" would be the same as for the no-action alternative. The consequences would be as described in Chapter III, but also without the mitigating measures.

Both agencies may approve the plan with modifications or changes although the procedures are different between the agencies for exercising this alternative. Possible modifications that the agencies considered are discussed in Chapter I as "alternatives" to the applicant's plan.

As modifications, the agencies considered two alternative county road access routes, two alternative mine access road routes, and three alternative tailings disposal locations. All alternatives were eliminated from detailed study in the EIS except for one country road alternative and one mine access

road alternative. Chapter I describes each alternative and briefly discusses the reasons for eliminating from further study all but the one mine access road and county road access alternatives. Chapter IV compares the mine road access and county road alternatives with the applicant's proposal.

The agencies may also approve the plan and require special mitigating measures to reduce expected impacts. Chapter III discusses the consequences of plan approval and mitigating measures considered by the agencies.

After reviewing the public comments on the draft EIS, the agencies will choose a preferred administrative alternative in the final EIS.

CHAPTER I: THE PROJECT, ALTERNATIVES, AND OTHER ACTIVITIES

JARDINE JOINT VENTURE'S PROPOSAL

The Jardine Joint Venture Project is located near Jardine, Park County, Montana (figures S-1 and IN-1). The project is in the Bear Creek drainage, a tributary to the Yellowstone River, on the southeast flank of the Absaroka Mountain range. Jardine and the mine are located about five miles northwest of Gardiner, Montana, and 52 road miles south of Livingston, Montana.

According to the Jardine Joint Venture (JJV) application, mine construction could begin as early as the spring of 1986. The mine could be fully operational in mid-1988. Yielding an average of 1,050 tons of ore per day, five days per week, the mine has an estimated life of 20 years, through 2008. The gold would be concentrated and refined in the mill. The mill would process about 750 tons of ore per day, seven days a week. Most of the ore would leave the mill as waste-product tailings. These tailings would be deposited in a sealed disposal area within a mile of the mill or backfilled into the mine. The project would last for at least 22 years, including 18 months of construction, 20 years of production, and at least one year of final reclamation.

The project area encompasses 410 acres, of which only 93 acres would be disturbed by construction and operation (table I-1). The permit area would cover parts of the northeast, northwest, and southwest quarters of Section 9 and southeast quarter of Section 8 of T9S, R9E. Most of the disturbance would be on private land owned by the applicant (figure I-1). Only a small area of Forest Service land would be covered by tailings. About 28 percent (102 acres) of the proposed disturbance area has been disturbed by previous mining (see Chapter II--Vegetation).

Mining Plan

Mining at the project would be underground. Five levels would be developed into the new mining area at 150-foot vertical intervals in Mineral Hill. Levels would be 9 feet by 9 feet and constructed using rubber-tired diesel equipment. Four of the levels--600, 750, 900, and 1,050--were constructed during earlier mining, and all but the 600 level are caved in at the portals because of rotted and collapsed timbers. These portals would be reopened and stabilized. Only the 450 level would be new. All levels would be extended to new mining zones east and below the Bear Gulch fault.

Table I-1: Surface Area Disturbance

Facilities	Acres
Waste dumps at portals and surface water control structures	7.7
Soil stockpiles	4.0
Mill and mine facilities, parking lots (including disturbance at 1,050 level)	12.0
Tailings disposal site and support facilities	53.0
Roads	7.3
Slurry lines	3.0
Gravel pit and waste plant	1.1
Old tailings (outside new tailings deposition)	2.5
Partially reclaimed old tailings near Bear Creek	2.2
Air shaft and access	0.1
Total disturbance area	92.9
Undisturbed permit area	317.1
Total permit area	410.0

Source: Jardine Joint Venture Project Application, 1984.

Open cut-and-fill stoping, breast stoping, vertical crater retreat mining, or some combination of the three, may be used to mine the ore body. All these methods entail excavating ore from individual chambers or stopes in the ore body. Gold-bearing ore would be broken by drilling and blasting. The ore would then be moved from each level through vertical drop shafts (raises) to the 1,050 level. At this level, the ore would be transported by truck or train to the bin storage or stockpile at the surface crushing plant. Most of the ore would be stored underground in raises and in stopes, minimizing the need for large storage areas at the surface (Olin Hart, Homestake Mining Company geologist, pers. comm., April 1985).

Additional ore may also exist in the Jardine district. The Crevice Mountain area produced gold and arsenic ore that was processed at the Jardine mills; the applicant owns or leases the mineral claims in the Crevice Mountain areas (see figure I-1). Redevelopment of the Crevice Mountain area or the additional ore reserves below the 1,050 level in Mineral Hill would require subsequent approvals by the regulating agencies.

Ore Processing

The mill facilities would be located as near as possible to the 1,050 level. The mill building would be approximately 200 feet long, 200 feet wide, and 60 feet high. Associated with the 18-acre mill site would be a maintenance shop, warehouse, laboratory, storage yard, parking lot, office buildings, change house, crusher, and ore storage bins.

Figure I-1: The applicant owns or leases the claims detailed in this land ownership map.

The milling process would begin with the crushing and grinding of the ore to expose the sulfide minerals. Water would then be added to form a slurry of 36 percent solids. This slurry would be subjected to froth flotation, a physio-chemical method of separating and concentrating the metals from finely ground ores. The slurry would be agitated, injected with air, and treated with a frothing agent. Other chemicals (collectors) added to the slurry would cause sulfides and precious metals to attach to rising air bubbles. A foamy froth containing metals would be skimmed from the surface of the slurry. The rest of the crushed rock (tailings) would remain submerged, and would leave the mill in slurry form. The tailings slurry would be piped back into the mine or to the tailings disposal site. The froth concentrate would be filtered and leached with cyanide to dissolve the gold. The leached tailings would be either piped to the tailings disposal site, or back to the mine for backfill. These tailings would contain very high concentrations of the sulfide form of arsenopyrite. The gold would be precipitated from solution by the addition of zinc dust. Finally, the gold would be refined. Table I-2 is a simple flow chart of the milling process. Reagents that would be used in the process are Aerofloat 280, Aero 350 Xanthate, Aerofroth 76, Separan NP10, and sodium cyanide (see appendix 7).

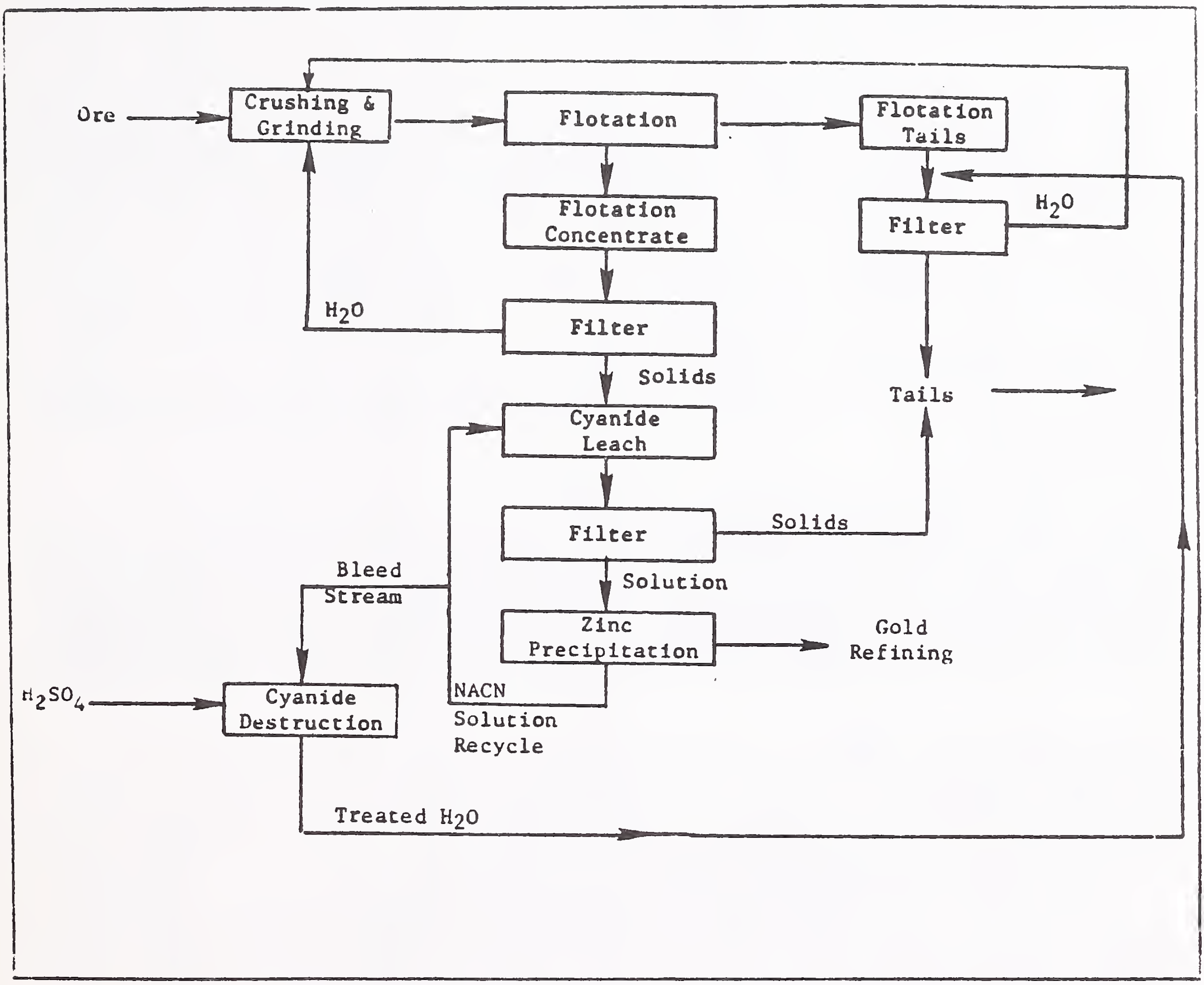
Tailings Composition

The tailings would consist principally of fine-grained, silt-sized ore. This material would undergo a series of steps to liberate gold in its free form. The two major steps in the ore beneficiation process are bulk flotation and cyanidation. Both these processes produce wastes that would go to the tailings dump area or would be backfilled in the mine stopes.

Wastes associated with the bulk flotation process account for about 95 percent of the tailings that would go to the dump or be backfilled in the mine stopes. Wastes associated with the cyanidation process contribute only about 5 percent of the total tailings. Reagents added during the bulk flotation process are relatively non-toxic. Cyanide used in the final ore processing can be quite toxic in small amounts if introduced into the environment (see appendix 7).

The bulk float tailings, which would comprise about 95 percent of the tailings, would have relatively low heavy-metal concentrations, except for arsenopyrite. Arsenopyrite concentrations (total) in the bulk float tailings could exceed 1 percent based on concentrations found in abandoned tailings ponds from ore mined from Mineral Hill. The cyanide tailings (5 percent of the total tailings produced) would contain relatively high levels of pyrite, manganese, arsenic, and cyanide. Most of these constituents would be chemically and physically bonded to other constituents in the tailings. Soluble arsenic, manganese, and cyanide concentrations in the slurry water would be slightly above drinking water or aquatic life criteria. For this reason, the tailings would be disposed of in a lined tailings dump or backfilled into dry underground workings.

Table I-2: Simple Flow Chart of the Milling Process



Tailings Disposal

About sixty percent of the slurry waste material (tailings) would be piped to the tailings disposal dump; the remaining 40 percent of the tailings would be piped to the 450 level and used as fill in the mine. Saturated tailings would be pumped into the mine adits, and slurry water from backfilled tailings would drain by gravity. Waste water would then be channeled by ditches to underground sumps where it would be pumped back into the mill circuit. Water would be removed from the tailings at the disposal dump by a belt filter or cyclone separator or similar equipment, reducing the water content in the tailings to about 15 percent. The water would be collected in a return water pond and pumped back to the mill for reuse. The capacity of the pond would be about 800,000 gallons; however, during normal operation the pond

would contain only about 200,000 gallons of water. The dewatered tailings would be deposited using a conveyor-stacker operation. If the conveyor failed for a prolonged period, the dewatered tailings could be deposited by truck.

The tailings disposal facility would be constructed in four stages. Each stage would have the capacity for about five years at the projected production rate. Stage one would involve construction of the tailings dewatering and pumpback (process) plant and associated facilities. About 10 acres would be disturbed. Deposition of the tailings would begin at the downstream end of the dump. All aspects of the tailings pile would have a 33 percent slope except for the upstream working face. The active face would be steeper, developing at the natural angle of repose of the dry tailings--about 50 percent. As deposition continues, the face of the pile would advance upstream.

The maximum height of the pile would be about 125 feet. As the active face advances, the side slopes of the dump would be stabilized and reclaimed. The active face would vary in area between five and nine acres during the life of the project.

During stage two, the process plant would be moved upstream within the limits of the stage three impoundment area. The topography of the terrace is such that of the impoundment would rest on the existing terrain without the need for embankment. The existing upper tailings would be removed and placed within the stage two impoundment. The old tailings could be reprocessed before placement in the disposal facility. The historical lower tailings would also be removed and placed within the impoundment.

During stage three, the process plant would be located outside the impoundment perimeter within the area previously occupied by the historic upper tailings impoundment. Again, no embankment need be constructed. Tailings deposition would continue upstream.

The process plant would remain in the same location during stage four. An embankment on the west and north side of the impoundment would be constructed to control runoff because the topography slopes gently toward Bear Creek. Deposition at the active face would be modified to achieve a 33-percent slope, as the final limits of the dump are reached.

Tailings Disposal Facility

An embankment would be constructed around the lower end of the disposal area. The material for construction would come from within the disposal area. The internal slopes of the embankment would be 33 percent and external slopes would be 40 percent. The embankment fill would consist of compacted sands and gravels six inches or less in size. Eighteen inches of finer-grained material and topsoil would be placed on the embankment and revegetated. The maximum height of the embankment would be 35 feet, where it crosses a minor drainage on the terrace. The remainder of the embankment would be less than 10 feet high. Throughout the length of the embankment, a 20-foot crest width would be maintained to allow access. The disposal area would have a minimum capacity of 3.5 million tons and would be designed as a zero-discharge facility.

A dry layer of bentonite clay would be placed at the bottom of the disposal site. On top of this clay layer would be a sand layer and then a synthetic membrane liner. An underdrain system would be placed on top of the liner. Water collected by the underdrain system would drain to a small lined pond at the downstream end of the dump. This pond would have a capacity of 1.2 million gallons. During normal operation, the pond would contain about 200,000 gallons; the remaining capacity would be used to accommodate a major flood event and fluctuations in the operating and hydrologic cycle of the facility. Water needed for ore processing would be pumped back to the mill.

The collection pond liner would be lined with synthetic membrane liner similar to that used beneath the tailings disposal site. A leak detection system would be incorporated into the disposal facility. This system would consist of a series of collection pipes placed in a sand layer sandwiched between the synthetic liner and bentonite layer. The pipe collection system would drain to a monitoring well.

The applicant's proposed tailings site is located at the southern boundary of the proposed permit area. Bear Creek flanks the west side of the site and Bald Mountain the east. The site is located on two terrace levels with a 75-foot elevation difference between the two terrace levels. The terrace is made up of glacial till or alluvial material deposited on top of alternating sequences of lakebed and older (high-energy) gravel sediments. The unconsolidated terrace deposits are over 300 feet deep in the central part of the valley.

Water Use and Management

Total water required for the operation is estimated to be 203 gallons per minute (gpm). The mill would need 200 gpm. Of this, 188 to 195 gpm would be recycled and the additional 5 to 12 gpm would be obtained from Pine Creek or Bear Creek. The 3 gpm of potable water required would be withdrawn from Pine Creek, Bear Creek, or a ground water well.

Seepage from the tailings and any direct precipitation on the pile would be collected by the underdrain system and routed to the seepage collection pond. This water would then be pumped back to the mill via the dewatering plant.

If the recycled water is high in total dissolved solids, two sludge ponds may be constructed between the embankment and the seepage collection pond. The water could then be treated to precipitate the dissolved solids before the water is returned to the mill.

Water draining from the tailings backfilled into the mine would be collected in ditches within the mine, routed to a sump, and pumped back into the mill circuit.

Surface water runoff from disturbed areas, topsoil piles, and waste rock areas would be collected by sediment collection ditches and routed to settling ponds. The ponds would be sized to retain the runoff from a 25-year, 24-hour

storm. Each pond would be designed to empty by seeping within seven days. All runoff from adjacent undisturbed areas would be collected by a series of trenches and diverted into the drainage below the seepage pond.

About 3 gpm of potable water would be routed into the septic system and discharged to a drainfield located on the Bear Creek terrace adjacent to the mine office building. Details of the septic system would be prepared at a later date.

Utilities

The project would require about 3.5 megawatts of electricity, which the Montana Power Company (MPC) would supply. The existing transmission line from Gardiner to Jardine cannot be converted to a 69-kilovolt (kV) line. A new 69-kV line would have to be built from the substation outside Gardiner along the five miles of the county road to Jardine. The exact location of the line would be determined by MPC after discussions with affected landowners and governmental managing agencies (MPC, pers. comm., May 15, 1985).

Roads

The applicant's proposed road would direct traffic through Gardiner and to the mine via the existing county road and Z-Hill. The applicant proposes to upgrade the existing county road, put in new guardrails, widen the road to 28 feet (10-foot shoulders), regrade blind corners and put in erosion-control features.

To access the mine from the Jardine Road, the applicant proposes to construct a new segment of road and new bridge from the Jardine townsite to the southeast that would connect with the Bear Creek and Crevice roads (figure I-2).

Mine Employment

During the 18-month construction period, the company and its construction contractor would hire as many as 65 people, with a quarterly average of 45 employees.

The 30 administrative and laboratory personnel, and 20 maintenance/shop employees would work a regular day shift, five days a week. The 75 underground miners would work two shifts per day, five days a week. The 25 mill operators would work three shifts per day, seven days a week. About nine months after construction is complete, employment would stabilize at 150.

Bonding

The applicant must file a bond with the Department of State Lands (DSL) of not less than $200 and not more than $2,500 for each acre disturbed. Despite these limits, however, the bond must not be less than the estimated cost

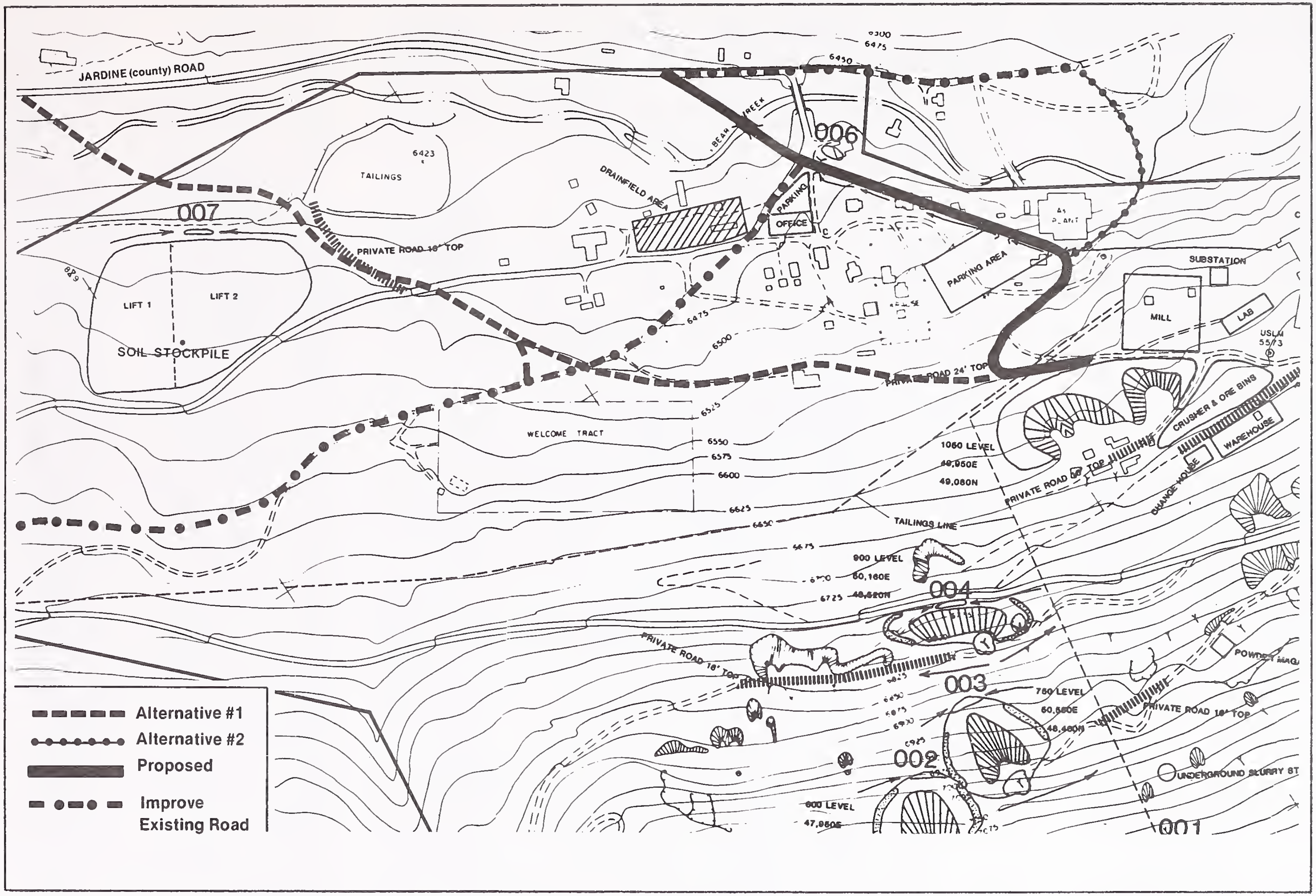


Figure I-2: A short segment of new road would be constructed near the mine. The company proposes to realign and widen the existing crossing over Bear Creek. Two alternative routes were developed by the agencies.

to the state of reclaiming the disturbed lands (82-4-328[1], MCA). The bond would not be released until DSL and the U.S. Forest Service determine that reclamation has been successfully completed.

The Forest Service may require additional bonding if it determines that the bond held by DSL is not adequate to reclaim national forest lands or is not available for Forest Service requirements. The bond amount would equal the estimated cost of stabilizing, rehabilitating, and reclaiming the area of operations on national forest system lands. The bonding level would be adjusted if the plan of operations were modified.

Reclamation

All structures would be dismantled and sold as salvage or relocated to another project upon completion of operations. Building foundations would be removed and disposed of in the final unit of the tailings disposal site or portions may be buried in the facilities area during grading. The ore stockpile would be removed and milled. The tailings pipelines would be removed at the end of operations. After mining is complete, all mine openings would be sealed temporarily or permanently, depending on whether access is required. If activity at a particular level is complete before the end of operation, reclamation would be conducted when activities are finished at that level. All remaining waste rock dumps would be reclaimed at the conclusion of mining. All unsalvaged mining debris would be buried at the end of operations. All solid waste disposal would be in compliance with local and state ordinances.

Cut and fill slopes on roads to remain after mining would be reclaimed during the first appropriate season after construction or improvement. This reclamation includes new segments of the county road and existing roads on Mineral Hill that are minimally improved for access. Roads not proposed as part of the post-operation land use would be reclaimed at the end of operations.

Interim revegetation on soil stockpiles, the slurry-line corridor, sediment-control structure areas, tailings disposal site embankment, and areas disturbed during facilities construction would occur during the first appropriate season after construction. Final reclamation on these sites would occur when the project is over.

The tailings disposal site would be reclaimed in stages. After year 2, about 2.3 acres per year would be reclaimed. The seepage pond downstream of the impoundment, and one permanent diversion above and to the east of the tailing disposal site would not be reclaimed. The existing upper tailings pond would be reclaimed in conjunction with tailings disposal during the second phase of the operation. No time frame has been established for removing and reclaiming the existing lower tailings pond.

The applicant's stated reclamation goals are:

--reestablishment of wildlife habitat, particularly on the tailings disposal area and on Mineral Hill,
--providing for domestic livestock use, particularly in the facilities area,

--protection of water quality in Bear Creek,
--providing public access to federal lands,
--protecting public health and safety by removing potential hazards, primarily mine openings and facilities.

Monitoring

Revegetation success would be monitored by sampling reclaimed areas one year after starting reclamation. Reclamation and revegetation would be analyzed for several years after reclamation is initiated.

The slurry and backfill lines would be monitored for leaks by:

--continuous flow balancing at the mill and process areas,
--daily visual inspections,
--other electronic or mechanical means developed during design.

Settling ponds would be inspected in the spring and fall, and cleaned when the sediment accumulation exceeds 12 inches. Ditches would be inspected annually and erosion and bank damage repaired as necessary until bond release.

Surface water would be sampled quarterly upstream and downstream from the operation. Special sampling would be done as needed, after discharges from sediment control structures, for example. A ground water monitoring program would be developed after a year of quarterly samples from the seven existing wells. This program would be designed in consultation with the Department of State Lands, the Department of Health and Environmental Sciences, and the U.S. Forest Service.

Embankment material surrounding the downstream and upstream ends of the dump would also be monitored to detect settlement or horizontal movement. Survey monuments will be installed along the embankment crest and along the crest of the slope above Bear Creek. If movement were detected from the survey data, additional monitoring equipment, such as inclinometers, would be installed to characterize the extent and location of movement. Should the movements be determined to have potential impact on the tailings facilities, remedial measures would be taken to protect the facilities.

ALTERNATIVES

The applicant's proposal would have certain disadvantages:

--Construction of a new road and bridge to the project area from the Jardine Road as proposed would remove five structures within the Jardine Historic District.

--Workers commuting to the minesite would increase traffic on the Jardine Road. Dust and traffic on the Jardine Road could become a nuisance and hazard for residences and commercial businesses located on the east side of Gardiner.

--Location of the tailings dump as proposed would be visible from portions of Yellowstone National Park and would affect wildlife habitat.

To remedy these disadvantages, a number of modifications (or alternatives) of the applicant's plan were considered by the agencies. These included mine access road alternatives that would avoid removal of structures within the Jardine Historic District, county road alternatives that would bypass the eastside Gardiner residential and commercial area, and alternative tailings disposal locations that would reduce the project's visibility from the park and its effects on wildlife habitat.

Only one mine access road alternative and one county road alternative were considered reasonable alternatives by the agencies. Reasons for eliminating the other alternatives are briefly discussed in the following sections. An analysis of the agencies' selected mine access road and county road alternatives is found in Chapter IV.

Mine Access Road Alternatives

DSL evaluated two mine access road alternatives (figure I-2). Both alternatives would require a bridge across Bear Creek. Alternative 1 would connect the Jardine Road with the mine facilities south of the applicant's proposed access road. Mine traffic would be routed around the town of Jardine, the mine facilities, and the Jardine Historic District. The road would be constructed to an eight percent grade.

Alternative 2 would be located north of the applicant's proposed road. Like Alternative 1, it would avoid structures in the historic district. However, traffic would be routed through the Jardine townsite, similar to the proposal. Grades in excess of 16 percent would be required to reach the mill with Alternative 2; grades this steep would be unacceptable.

Alternative 2 was dismissed because it offers no distinct advantages over Alternative 1. That is, although it avoids removing historic structures, it does not offer the advantage of routing mine traffic around the Jardine townsite. In addition, the steep grades are unacceptable.

The agencies consider Alternative 1 the only reasonable alternative to the proposal.

County Road Alternatives

Reconstruction of the Jardine Road using existing and new right-of-way is the only option that would reduce the inconvenience and hazard of routing mine traffic through the residential east side of Gardiner. Two county road alternatives were identified that would bypass Gardiner (figure I-3).

Alternative route A would start near the airport, gradually climb the steep hillside, and connect with the existing county road above Z-Hill.

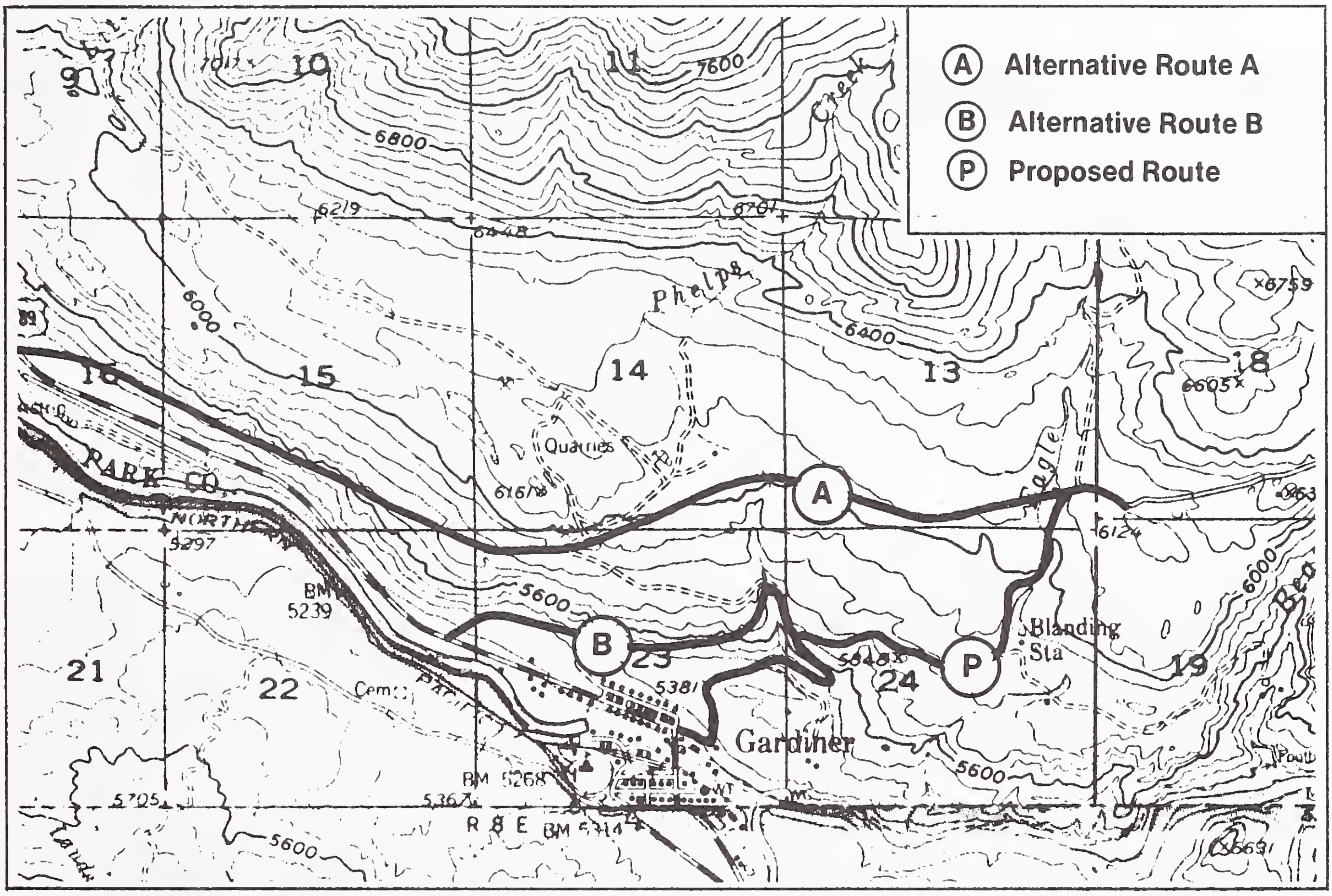


Figure I-3: The company proposes to upgrade the existing county dirt road (P) out of Gardiner. The agencies identified two alternative routes (A and B) that would avoid the town.

Alternative route B would start at Highway 89 just west of Gardiner and climb the hillside just north of Gardiner. It would connect with the existing county road in the same place as Alternative route A. This alternative is not considered feasible because of slope steepness. In addition, the amount of rock that would have to be removed during construction would pose a safety hazard to residences living at the toe of the slope.

Alternative route A is considered the only reasonable alternative to the applicant's proposal. This alternative would route project traffic around the town of Gardiner, reducing the hazard and inconvenience to residents and businesses along U.S. 89 and Z-Hill.

Tailings Disposal Site Alternatives

Only three areas suitable for tailings disposal were identified within a 10-mile radius of the applicant's project. These included the proposed tailings disposal area, Deckard Flats, and the terrace area above Gardiner. Wilderness and national park boundaries, unsuitable topography, conflicting land uses, natural hazards, and wildlife travel corridors within this 10-mile radius limit suitable sites to these three areas.

From these areas, three alternative disposal sites (sites 2, 3, and 4) were identified (figure I-4). These sites and the proposed site (site 1) were evaluated by Steffen Robertson and Kirsten Inc. in the applicant's permit application (1984), and by DSL and USFS personnel. The engineering feasibility of all four sites was assumed to be about the same. However, none of the alternatives provided significant advantages over the applicant's proposal and, for this reason, all were eliminated from further study.

The following is a description of the alternatives and a brief summary of the agencies' reasons for dismissing them from further study.

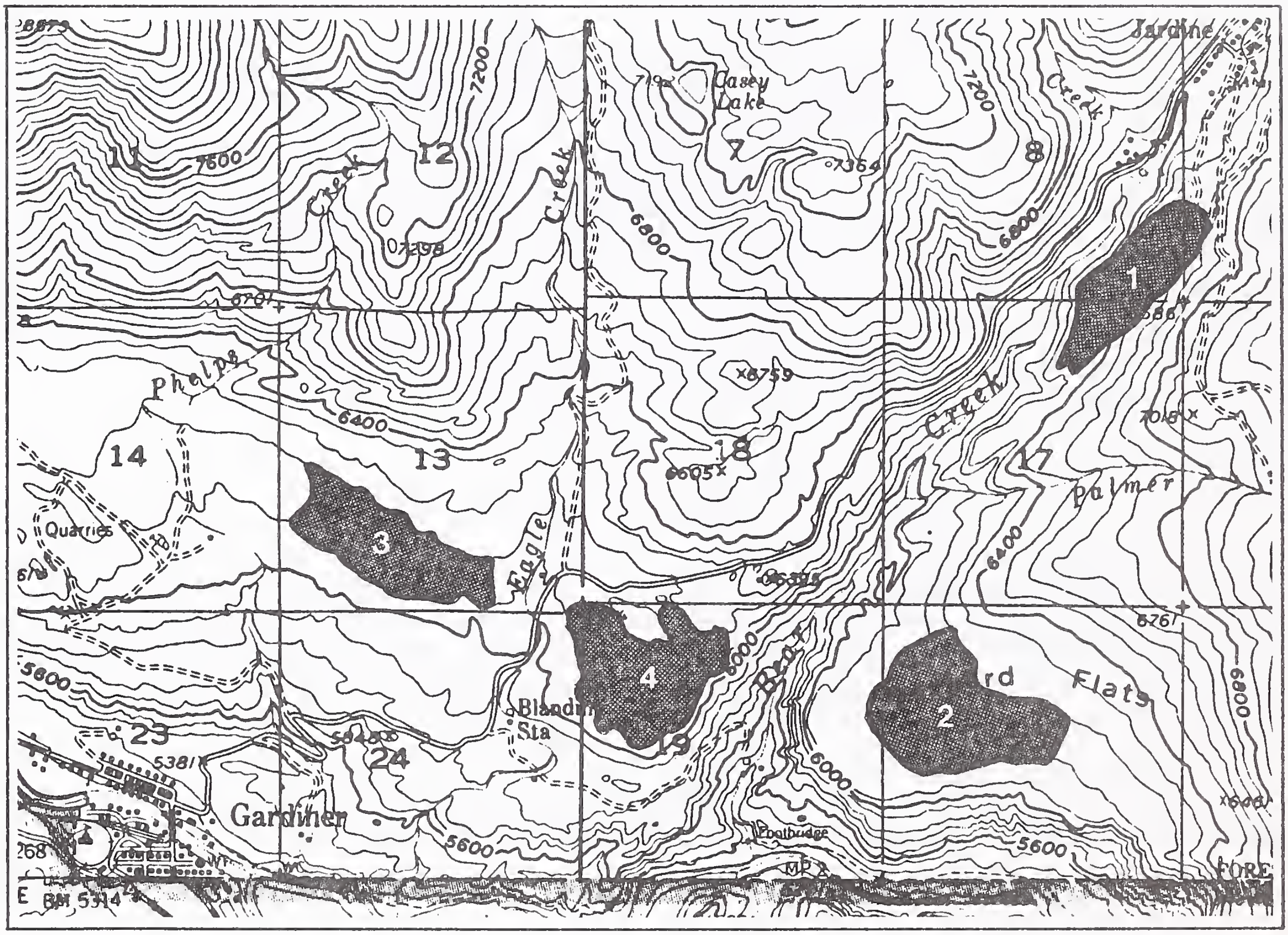


Figure I-4: Four tailings disposal sites were analyzed. Sites 2, 3 and 4 were dismissed because of major environmental problems. Site 1 is the applicant's proposed site.

Site 2 is located about 2.5 miles south of the project area at Deckard Flats, on an elevated terrace on the east side of Bear Creek at its confluence with the Yellowstone River. The site is covered by a thin veneer of glacial till and alluvial material over a highly fractured basalt. The basalt lies over a deposit of sands, gravels, and boulders. Total thickness of these materials exceeds 250 feet. Tailings from the mill would be transported to the disposal site in a 2.5-mile slurry pipeline that would parallel Bear Creek and cross Palmer Creek. The tailings would be dewatered and disposed of in a dump similar to the applicant's proposal.

Compared to the applicant's proposal, site 2 would be highly visible from Yellowstone National Park and from around Gardiner. It is also located in an elk winter concentration area and is near bighorn sheep habitat (the Yellowstone River cliffs of Deckard Flats).

Site 3 is located about three miles southwest of the project on a gently sloping terrace above the Yellowstone River about one mile north of Gardiner, Montana. The geology of the site is similar to that of site 2. Tailings would be transported to the disposal site in a slurry pipeline that would cross Bear and Eagle Creeks and parallel Bear Creek for about three miles. The tailings would be dewatered and disposed of in a dump similar to the applicant's proposal.

Compared to the applicant's proposal, site 3 would be highly visible to park visitors traveling from Mammoth Hot Springs to Gardiner. It is located on the fringe of an elk winter concentration area and within the late-season elk hunting area. In addition, the site is located only one mile upstream from Gardiner and 3/4 mile upstream from a residential area. The city of Gardiner currently derives about 225 gpm from a spring in the vicinity of site 3.

Site 4 is located near the U.S. Forest Service Blanding Station between sites 2 and 3, on a terrace west of Bear Creek near the confluence with the Yellowstone River. The geology at this site is also similar to that of site 2. Tailings would be transported three miles to the disposal site in a slurry pipeline that would cross Bear Creek. Disposal of tailings would be similar to the applicant's proposal.

Compared to the proposal, site 4 would be highly visible from Yellowstone Park and around Gardiner. People now live adjacent to the downstream boundary to the site. The site is within both elk winter range and the late-season hunting area. Site 4 could have slightly more impact on grizzly bear. It is located near (or would cover) an apple orchard at Blanding Station. In October, 1981, seven grizzlies fed in this orchard (Knight et al., 1982 _in_ Westech 1984).

In summary, none of the disposal site alternatives offers distinct advantages when compared to the applicant's proposal. Therefore, these alternatives are not considered further in the EIS.

OTHER ACTIVITIES IN THE PROJECT AREA

Logging

The U.S. Forest Service (USFS) is selling timber in the Palmer Co-op sale area which is now being cut. Two hundred and thirty acres of the 400-acre sale area will be logged. Logging began in July 1984 and is scheduled to end September 30, 1986. The sale area is on Sections 14, 15, 22, and 23 of T9S, R9E near Palmer and Crevice Mountains, east of Gardiner. Four irregular units would be clearcut. Total harvest would be 140 acres per year. During the two years of logging, 1.5 miles of new roads would be built; 1,600 logging truck trips and 3,000 pickup truck trips would be added to the traffic on the Jardine Road.

After logging, slash would be piled by machine. The logged areas would revegetate naturally. Gates would be built on all new roads, with cooperative road management with private landowners.

The Gallatin National Forest Draft Forest Plan included two timber sales--the Pine Creek and Parker-Eagle--which were deleted after publication. The new 10-year plan (through 1996) entails a cutting unit of about 25 acres per year, east and north of Gardiner and near Pine Creek, east of Jardine. Exact locations have not been specified. (Pers. comm., Larry N. Lewis, District Ranger, Gallatin National Forest, September 16, 1985.) After logging, slash would be piled by machine. The logged areas would revegetate naturally. Gates would be added to new roads or they would be closed permanently.

West Gardiner Access

The USFS is proceeding with an in-depth analysis to determine access requirements for National Forest Service lands west of Gardiner, just north of Yellowstone Park. The 40,000 acres cover eight drainages. County roads access the lower reaches of these drainages. In three drainages (Divide Creek, Trail-Sunlight Creek, and Sphinx Creek) there is access to National Forest lands. In the other five drainages (Aldridge, Mol Heron, Upper Cinnabar Basin, Horse Creek, and Skull Creek), a narrow band of private land lies between the county road system and National Forest lands. In the Draft Environmental Assessment of the West Gardiner Access Program, the USFS recommended that access be acquired into each of the units. Their preferred alternative would allow "...seasonal public use and year-long administrative use in each unit. Public use restrictions will be established based on a cumulative effects analysis for grizzly bear management." Final decisions and implementation are expected to be complete by the end of 1985.

CHAPTER II: THE EXISTING ENVIRONMENT

GEOLOGY

The geologic setting of the Gardiner/Jardine area is strongly influenced by geologic events that have occurred in the greater Yellowstone Park/Beartooth Mountain area. Although the Yellowstone Park/Gardiner area is more complex than that found in the rest of the Rockies, the general processes affecting this area were often similar. Very old metamorphosed marine deposits--some as old as three billion years--dominate the area north and east of the Gardiner fault (see figure II-1). These sediments host the gold-bearing ore that the applicant proposes to mine. Volcanic sediments formed massive quartz-rich horizons bearing minor amounts of gold, sulfides, and tungsten (scheelite), interbedded with quartz-biotite schists and biotitic quartzites.

The remains of volcanic activity dot the landscape of the greater Yellowstone region. Some of the oldest volcanic rocks date back over 50 million years; the most recent are less than two million years old. Consolidated ash deposits, lava flows, and crystallized magmatic intrusions were the end results of these volcanic events, similar to the dramatic processes witnessed during the 1980 eruption of Mount St. Helens in Washington.

Three episodes of glaciation over the last million years have left glacial debris and glacial-related deposits and lakes scattered across the region. More recent processes of erosion and stream action have further modified the landscape. Bear Creek and the Yellowstone River in the Gardiner/Jardine area are in the process of active downcutting. Thick glacial-related valley-fill deposits in the Jardine area are being eroded by downcutting and the gradual meandering of Bear Creek.

Topography

Gardiner is located at an elevation of about 5,300 feet; Jardine lies at about 6,500 feet. The Gallatin Range forms the western boundary of the Yellowstone Valley, and the Absaroka and Beartooth Mountains are to the east. Locally, these mountains exceed 9,000 feet, towering well above Bear Creek and the Yellowstone River.

The project area is on the south side of Bear Creek, adjacent to the historic town of Jardine. Mineral Hill forms the southeastern margin of the permit area; the top of the mountain is about 7,600 feet. The Bear Creek side

Figure II-1: The geology of the project area reflects its origins of Precambrian bedrock, volcanic formations, and more recent, unconsolidated deposits.

of the hill is steep, exceeding 50 percent slope in many places. The valley bottom of the permit area (at 6,300-6,500 feet) is flat to moderately sloped (less than 20 percent).

Bedrock of Mine Area

Ancient, metamorphosed marine sediments host the gold-bearing ore that the applicant proposes to mine. Volcanic sediments were metamorphosed and formed massive, quartz-rich horizons bearing minor amounts of gold, sulfides, and tungsten (scheelite), within quartz-biotite schists and biotitic quartzites.

Iron-chemical precipitates, which formed during periods of stability when volcanic activity subsided, contain higher sulfide, gold, arsenic, copper, and iron concentrations than the volcanic sediments. Minerals in the gold-bearing zone include arsenopyrite, pyrrhotite, pyrite, chlorite, quartz, and amorphous carbon (project application, 1984).

The thickness of the gold-bearing strata of Mineral Hill varies from just a few inches to as much as 75 feet thick. Gold ore grades range from a trace to high-grade, nugget-bearing ore. The average production grade would probably run about 0.20 ounces per ton (Olin Hart, Homestake Mining Company geologist, pers. comm., June 4, 1985).

The original layer-cake sequence of deposits has been folded, twisted, and uplifted over 10,000 feet by the several periods of deformation that followed. A cross-sectional view of the underground workings of Mineral Hill is depicted in figure II-2. The Bear Gulch fault, which cuts through the center of Mineral Hill, offsets the bedrock 100 to 300 feet, west side down. For this reason, underground mining has been confined primarily to the western half of the hill.

Surface Deposits of Bear Creek

At Jardine, Bear Creek was forced to the western edge of the valley by the thick glacial terrace deposits. Up to a third of the original deposits has been removed from Jardine since the last episode of glacial deposition some 8,500 to 13,000 years ago. Drilling records of wells completed in the Bear Creek terrace indicate it is composed of alternating sequences of gravels, and lake bed sediments. At least three complete cycles of deposition are preserved, starting with a lakebed deposit at the bottom and culminating in a gravelly layer at the top. The lakebed deposits vary from about 50 to 100 feet thick in this terrace.

Undercuts along the terrace above Bear Creek and seeps discharging from the banks atop the lake bed deposits are responsible for occasional small slump sloughing off from the terrace into the creek. Two slumps adjacent to the existing unreclaimed upper tailings dump have occurred since 1971. During the early 1970s the Anaconda Copper Company, temporary owner of the Jardine properties, kept the tailings pond covered with water to hold down dust. Some of this water seeped into the underlying terrace and created a perched water

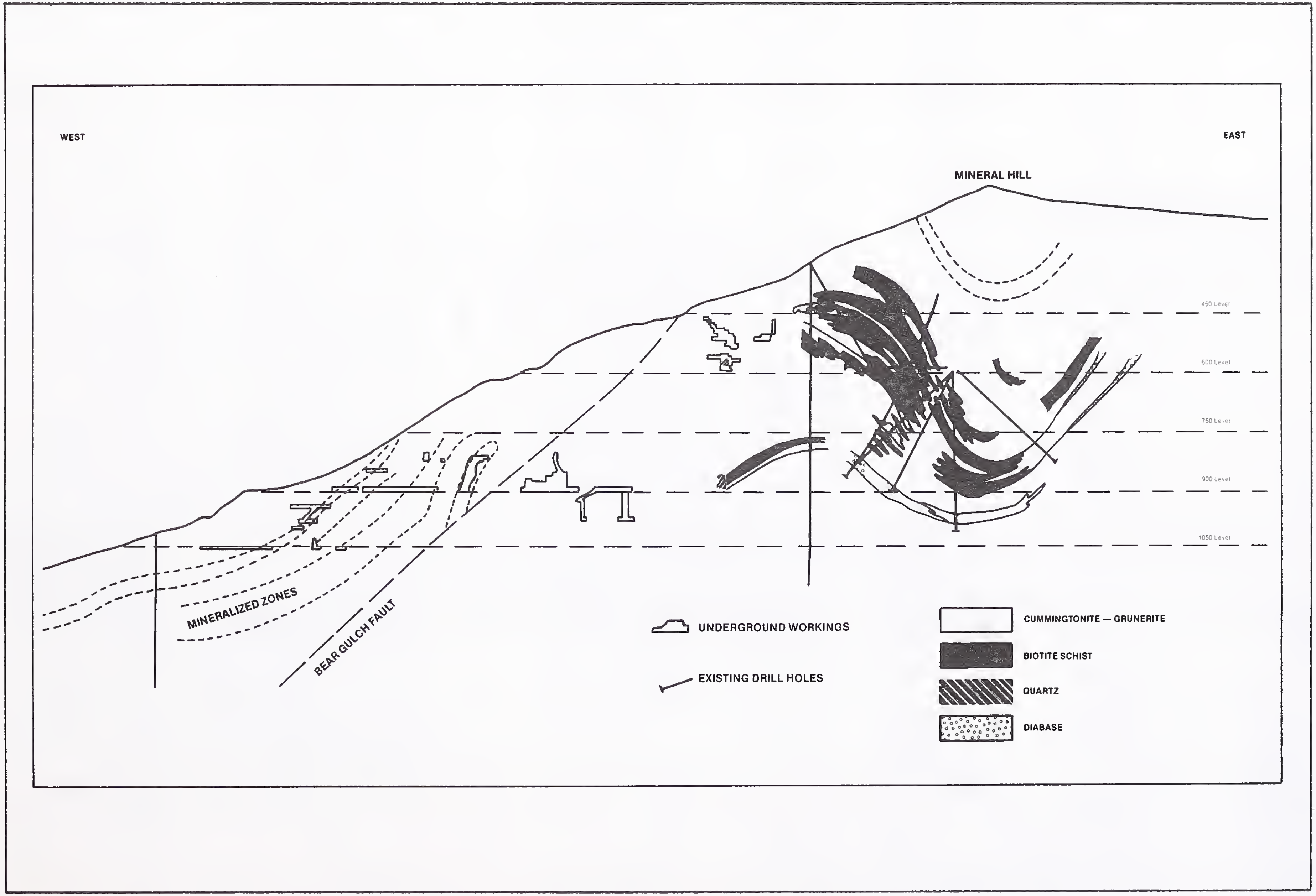


Figure II-2: Historic mining operations removed most of the gold-bearing ore from the mineralized zones west of the Bear Gulch fault. The applicant proposes to mine the gold-bearing zones (cummingtonite/gruenerite, biotite schist, quartz) east of the fault.

table on top of the lakebed sediments (see figure II-3). The added water, together with stream undercutting, caused two small sections of the oversteepened cutbank to slough off into the creek.

An older slump upstream of these two recent slumps indicates that slumps are a natural erosional process. Saturation of the old tailings by the Anaconda Copper Company probably accelerated the process.

Faulting and Earthquakes

Earthquakes are a result of two rock masses moving rapidly past each other along a fault. The energy released during an earthquake travels radially through the earth and is lost quickly. No local damage would be caused by an earthquake if it originated over 120 miles from the site. Within a 120-mile radius, locations of active faults and the strength and location of historically recorded earthquakes were used to determine the probability of occurrence of various degrees of ground shaking at Jardine (project application, 1984, p. 1-C-19). The results are presented in appendix 5.

The maximum credible earthquake likely to occur in this region would measure about 7.3 magnitude on the Richter scale (Hags, 1980, in project application, p. 1-C-36). Such a large earthquake within 10 miles of Jardine would create considerable damage even to well-built wooden structures. The ground and roads would be badly cracked in places, and mass failures, such as slumps into rivers, would be common. However, such a large event would probably occur about once every 10,000 years. Well-built structures near an earthquake of lesser intensity would probably be undamaged.

Several active faults (showing movement within the last one to two million years) converge on the Gardiner area including the Gardiner Fault (15 miles long), the Mammoth Fault (8 to 10 miles long) and the Pine Creek or East Gallatin Fault (20 miles long) (Witkind, 1975). The Gardiner Fault shows evidence of 400 feet of offset over the last two million years. From this information it was estimated that a moderate-to-large earthquake would likely occur along this fault every 500 to 1,000 years (Frazer, Waldrop, and Hyden, 1969, p. 75). The two other nearby faults probably have similar rates of faulting. Bear Gulch fault, which cuts through Mineral Hill, is probably inactive.

The Gardiner/Yellowstone Park area is located at the confluence of two zones of higher-than-average earthquake activity. The Intermountain seismic zone extends from Nevada through the Salt Lake/Wasatch Front area up through the Tetons to Yellowstone, then bends northwest through Three Forks and Helena, and dies out near Kalispell. This zone is the most active earthquake zone in the U.S. outside of California, Hawaii, Alaska, and Washington.

A second active earthquake zone also converges on Yellowstone Park. The Idaho seismic zone extends from central Idaho east into Yellowstone Park where it ends against the Intermountain seismic belt. Both the Idaho and Intermountain zones of active faulting are probably tied to deep crustal stress within the continent. The presence of near-surface molten magma under Yellowstone Park adds to the stress building up in the area. Recent ground-elevation measurements by the U.S. Geological Survey indicate that portions of the park have risen inches over a matter of years. Such rapid rates of differential uplift, if continued, could lead to large earthquakes within decades.

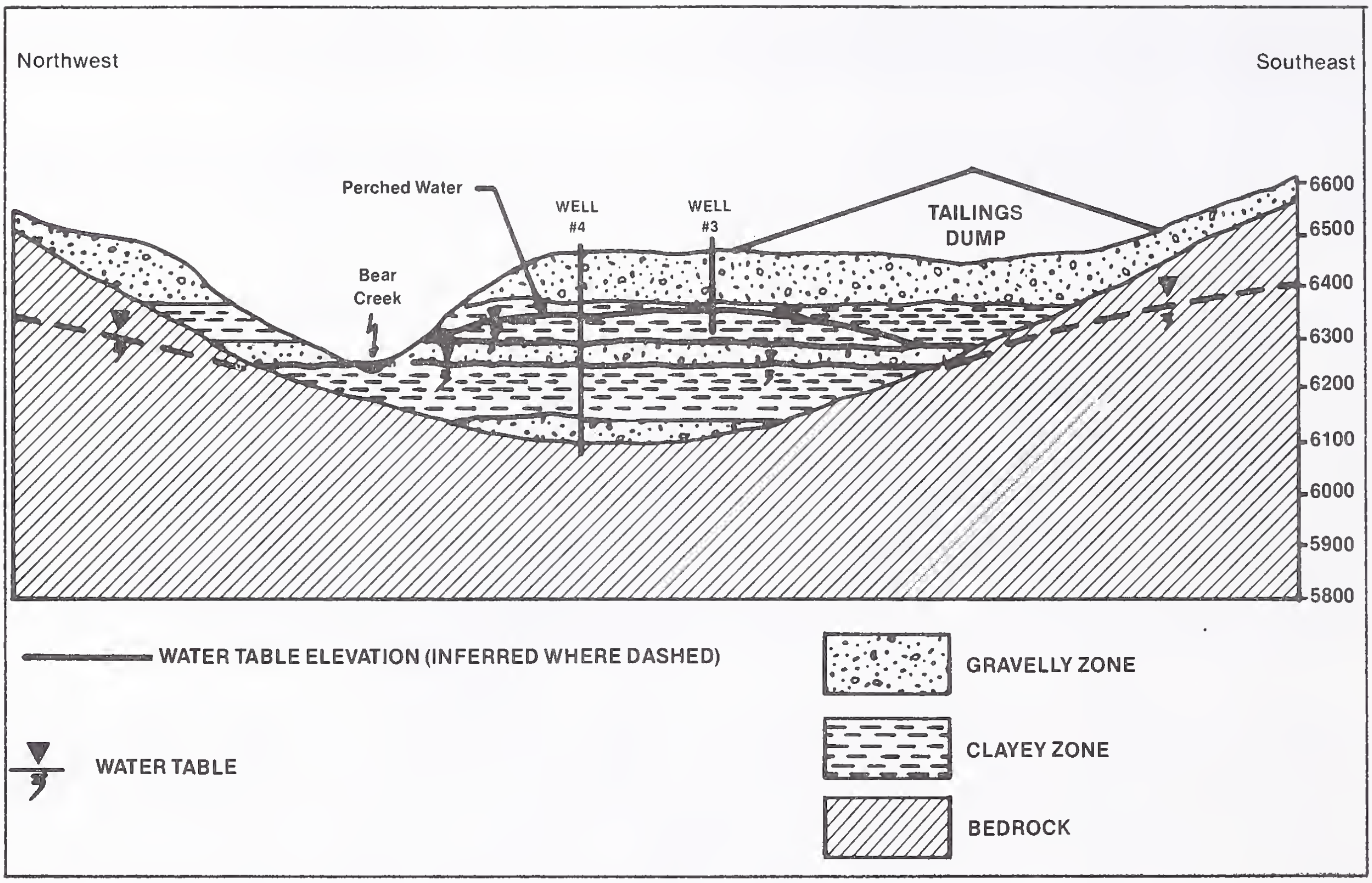


Figure II-3: The tailings dump would sit atop a high terrace of Bear Creek. The terrace is composed of layers of glacial gravels and clayey lake bed sediments. Ground water movement in the bedrock is generally toward the valley bottom. Within the valley alluvium, it moves downstream toward the Yellowstone River.

HYDROLOGY

Surface Water

The Bear Creek drainage is located in the southwestern portion of the Absaroka range in south-central Montana, and lies within the Gardiner Ranger District of the Gallatin National Forest (see figure II-4). The drainage flows southwest for about eight miles until it reaches the confluence with the Yellowstone River at the western edge of the Black Canyon of the Yellowstone just outside the northern boundary of Yellowstone National Park. The Bear Creek watershed encompasses about 44 square miles and is characterized by steep, deeply incised valleys and high mountain peaks at elevations between

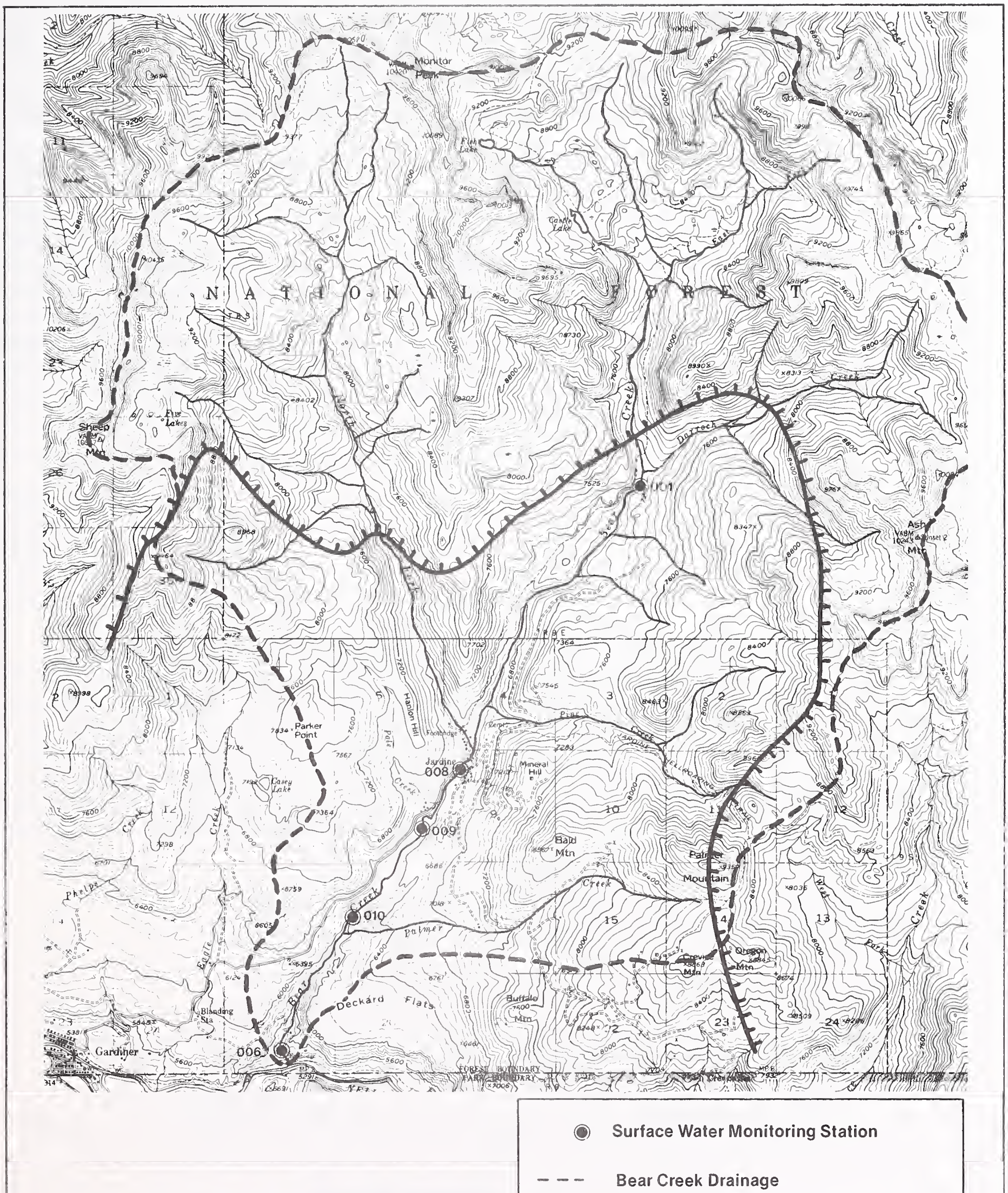


Figure II-4: Several tributaries feed Bear Creek before it joins the Yellowstone River. Surface water monitoring stations provided baseline flow and water quality data.

8,000 and 10,000 feet above sea level. The North Fork of Bear Creek drains 12 square miles of the eastern and southwestern slopes of Sheep and Monitor mountains. The main stem of Bear Creek drains about 32 square miles and is augmented by several smaller tributaries, including Darroch, Pine, Pole, and Palmer creeks. Statistics regarding the magnitude and frequency of precipitation events in the Bear Creek drainage are provided in Chapter II--Climate.

Monthly streamflow measurements were used to estimate long-term mean annual discharge, mean monthly discharge, and various points on the flow duration hydrograph using the Riggs' methodology (Riggs, 1968; Parrett, 1985). The long-term mean annual discharge of Bear Creek at Jardine is about 60 cubic feet per second (cfs). Mean monthly discharges range from a low of 12.5 cfs in February to a high of 270 cfs in June. Mean daily discharges for Bear Creek for different exceedance probabilities are presented in figure II-5. Exceedance probabilities are an expression of the percentage of time streamflow equals or exceeds the indicated value. Estimated peak discharges for Bear Creek at Jardine are presented in table II-1 (Westech, 1982).

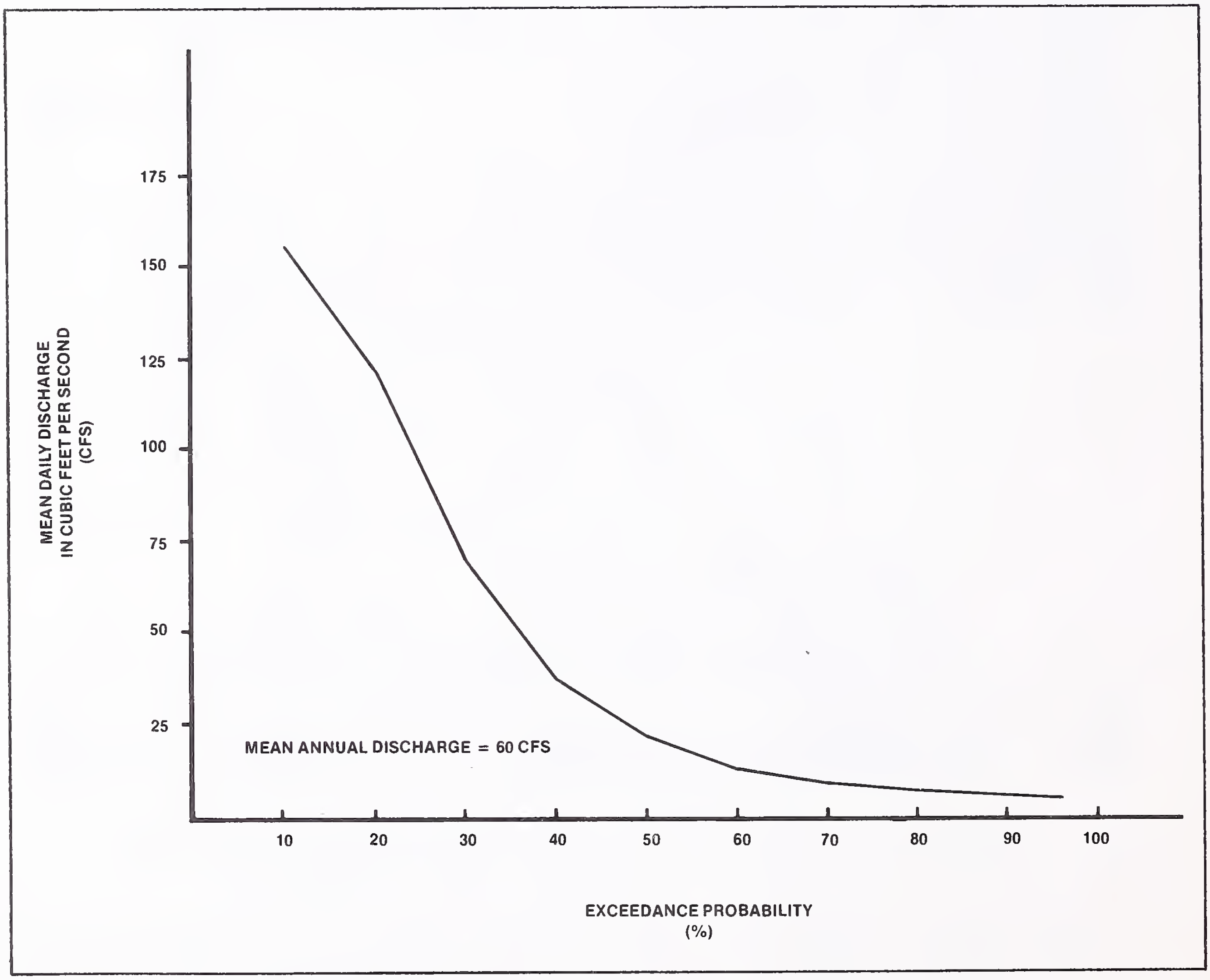


Figure II-5: Flows in Bear Creek are expected to be at least 21 cubic feet per second (cfs) half the time. Higher flows are expected less frequently.

On December 15, 1978, an order from the Board of Natural Resources and Conservation was signed, establishing minimum streamflows on behalf of the Department of Fish, Wildlife, and Parks (Peterman, 1981). The order granted water reservations of the twentieth percentile flow for the months of October through April and for the fiftieth percentile flow May through September. These reservations were established for Bear Creek from the mouth to the confluence with North Fork, and for North Fork until its confluence with Fish Creek (Department of Natural Resources and Conservation, 1979). The availability of flow for future appropriations based on estimated mean monthly flows for Bear Creek is presented in table II-2. The analysis indicates that during an average year there may not be sufficient flow in Bear Creek to satisfy the minimum flow requirement established for fish and wildlife.

Estimates of streamflow and water availability reflect the depletions associated with existing water appropriations. Water from Bear Creek and its tributaries has been used for agricultural, mining, domestic, and stock-watering purposes. Water rights claims for existing uses are summarized in table II-3 (Department of Natural Resources and Conservation, 1985).

Mean monthly streamflow for the Yellowstone River at the confluence with Bear Creek was estimated to determine the contribution of flow from Bear Creek. These streamflow estimates are presented in table II-4. During periods of snowmelt runoff, Bear Creek contributes only 2.5 percent of the natural flow of the Yellowstone River within the National Park boundary. During winter low flow the contribution is about 1.5 percent.

The headwaters of Bear Creek are located within the Absaroka-Beartooth Wilderness and are classified as A-1 by Montana statutes. The wilderness boundary is delineated on figure II-4. The proposed project is located outside the Absaroka Wilderness where Bear Creek is classified B-1. Waters classified A-1 or B-1 are suitable for drinking, culinary, and processing purposes after conventional treatment. B-1 waters may be used for agricultural and industrial purposes. A-1 and B-1 waters must meet the established water quality standards presented in appendix 6.

Table II-1: Magnitude and Frequency of Peak Discharge for Bear Creek at Jardine

Recurrence Interval (years)	Flow (cfs)
2	290
5	510
10	670
25	870
50	1,040
100	2,200

Source: Westech, 1982.

Table II-2: Availability of Flow in Bear Creek

Month	Percentile flow requirement[1]	Estimated long-term average discharge[2] (cfs)	Minimum instream requirement[3] (cfs)	Availability (cfs)
October	20%	25.0	18.20	6.80
November	20%	16.0	16.50	-0.50
December	20%	13.0	12.50	0.50
January	20%	13.0	10.10	2.90
February	20%	12.5	9.63	2.87
March	20%	13.0	10.80	2.20
April	20%	18.0	32.30	-14.30
May	50%	125.0	91.10	33.90
June	50%	270.0	290.00	33.90
July	50%	130.0	120.00	-20.00
August	50%	50.0	41.20	8.80
September	50%	35.0	34.50	0.50

[1] Percentile flow or flow exceedance probability is flow that would be equalled or exceeded a certain percentage of the time. The 50-percentile flow is equal to the median flow.

[2] Average standard error of the estimate = 100% (U.S. Geological Survey, 1985).

[3] Average standard error of the estimate = 30% (U.S. Geological Survey, 1985).

Baseline water quality samples were collected and analyzed on a monthly basis for the stations shown in figure II-4 beginning April 1981 for a period of one year. Table II-5 presents the list of parameters that were analyzed. The results of these analyses are provided in table II-6 for the upstream control station (#001), the station adjacent to the project area (#009), and the station at the confluence of Bear Creek and the Yellowstone River (#006). Water samples were characterized using criteria established by the U.S. Environmental Protection Agency (EPA) (1976) and the Montana Department of Health and Environmental Sciences (DHES) (1984). Quality criteria for aquatic life, public water supplies, recreation, irrigation, and livestock are presented in table II-7 (U.S. Environmental Protection Agency, 1976; Montana Department of Health and Environmental Sciences, 1984).

The results of the water quality analyses indicate that the waters of Bear Creek are calcium-carbonate type with low hardness. Total and dissolved metals are below the established criteria for all uses except for total manganese and iron, which occasionally exceed recommended drinking water standards downstream of Jardine. The pH varies seasonally between 7.2 and 8.6.

During the sampling period, total suspended sediment (TSS) in the main stem of Bear Creek was found in concentrations between 1 and 36 milligrams per liter (mg/l) with the highest concentrations adjacent to the disturbed area

Table II-3: Surface Water Rights Claims on Bear Creek Agricultural Uses

Creek	Number of claims	Acres irrigated	Approximate diversion (cfs)*
North Fork	1	5.0	0.14
Bear Creek	6	291.7	8.33
Pole Creek	1	26.0	0.74
Palmer Creek	1	55.0	1.57
TOTAL	9	377.7	10.78

*estimated (2 cfs per 70 acres)

Domestic Uses

Creek	Households served
Bear Creek	4
Palmer Creek	5

Mining Uses

Number of claims	Total diversions
(Homestake) 25	201.6 cfs
(Other) 19	27.9 cfs

Stock Watering Uses

Number of claims	Total number of head
9	732

Source: Department of Natural Resources and Conservation, 1985.

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near Jardine during spring runoff. Natural sediment yield to Bear Creek at the mouth was estimated to be about 550 tons per year (U.S.D.A. Forest Service, 1981). During the sampling period, disturbances associated with existing roads and historic mining activities contributed about 650 more tons per year. Concentrations of TSS are expected to vary from year to year and depend on the magnitude and frequency of precipitation and flood events.

Table II-4: Average Monthly Discharges in Cubic Feet Per Second for Various Locations in the Yellowstone River Basin

Month	Yellowstone River at Corwin Springs, Montana (Gage #06191500)	Gardner River near Mammoth, Wyoming (Gage #0619100)	Yellowstone River at confluence with Bear Creek*
October	1,530	127	1,403
November	1,190	111	1,079
December	967	101	866
January	841	95	746
February	828	91	737
March	905	90	815
April	1,460	128	1,332
May	5,780	489	5,291
June	11,500	770	10,730
July	7,020	327	6,693
August	3,270	166	3,104
September	2,000	139	1,861

Source: United States Geological Survey, 1982.
*Values estimated based on flow at Corwin Springs adjusted for inflow from the Gardner River. Estimated flow values may be somewhat larger than actual values.

Arsenic loading to Bear Creek increases below Jardine and appears to be highest during low-flow periods. Concentrations of arsenic vary from less than 0.005 mg/l at the upstream control station to 0.032 mg/l at the confluence with the Yellowstone River. The presence of arsenic in Bear Creek is attributable, in part, to wastes and seeps associated with the old ore processing site, existing tailings impoundments, and various dumps. On April 20, 1983, the Department of Health and Environmental Sciences (DHES) sampled seeps from the existing small tailings impoundment adjacent to Bear Creek. Results of this analysis indicated elevated concentrations of arsenic (0.087 mg/l), cadmium (0.015 mg/l), cobalt (0.024 mg/l), nickel (0.107 mg/l), manganese (0.856 mg/l), iron (3.342 mg/l), and aluminum (2.444 mg/l). In addition, a special water analysis by Westech in January 1981 indicated there were about 0.047 milligrams per liter of arsenic in Bear Creek below the existing small tailings impoundment in Jardine. Evidence of water quality degradation (rock stains) from these tailings is present up to one-quarter of a mile downstream (Larry Brown, DHES, pers. comm., March 3, 1985).

Although the concentration of arsenic in Bear Creek may be elevated due to past mining activities, the contribution of arsenic to the mainstem Yellowstone River is insignificant. In addition to the fact that Bear Creek provides only 1.5 percent to 2.5 percent of the flow of the Yellowstone River, the U.S. Geological Survey (USGS) has documented that natural levels of arsenic in the Yellowstone mainstem range between 0.005 and 0.024 mg/l. The USGS

Table II-5: Parameters for Baseline Water Quality Assessment of Bear Creek

Parameter
pH - conductivity (mhos/cm)
Temperature (C°) - DO
Total suspended solids
Total dissolved solids
Turbidity
Total alkalinity
Total nitrate (NO_3 + NO_2 as N)
Orthophosphate (as P)
Specific conductivity
Total ammonia (NH_3 + NH_4)
Sulfate (SO_4)
Calcium (Ca)
Magnesium (Mg)
Hardness
Arsenic (As)
Copper (Cu)
Iron (Fe)
Total acidity (pH 6.5)
Oil and grease
Carbonate
Bicarbonate (HCO_3)
Chloride (CL)
Sodium (Na)
Potassium (K)
Fluoride (F)
Aluminum (Al)
Cadmium (Cd)
Chromium (Cf)
Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Selenium (Se)
Vanadium (V)
Zinc (Zn)
Boron (B)
Cyanide (CN)

Source: Project application, 1984.

reports that natural sources from thermal activity within and near Yellowstone National Park are responsible for elevated arsenic levels (United States Geological Survey, 1983).

Table II-6: Results of Bear Creek Water Quality Analyses for Indicated Sampling Stations (Concentrations in Milligrams Per Liter)

Parameter	Criteria	Jan	Feb	Mar	Apr	May		Jun		Jul	Aug	Sep	Oct	Nov	Dec
Site 001 - Upstream Control Site															
Flow (cfs)		9	7	6	7	77	60	173	92	70	25	11	9	6	-
pH	6.5-9	7.5	7.9	7.6	7.4	7.2	7.3	7.5	7.9	8.3	7.9	7.9	7.1	8.2	8.11
TDS	250 mg/l	57	36	45	39	51	126	31	20	35	42	51	59	42	45
TSS	narrative	3	1	4	1	4	2	12	1	4	1	3	5	8	2
As	0.01 mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cn	0.005 mg/l							<0.005							
Fe	0.3 mg/l	00.03	<0.03	<0.03	<0.03	0.11	0.06	0.07	0.05	<0.03	0.03	<0.03	<0.03	<0.03	<0.03
Mn	0.05 mg/l							<0.02			<0.02				
SO_4	250	3	3	3	2	2	2	2	2	1	2	3	3	2	1
NO_x	10 mg/l	0.12	0.08	0.15	<0.05	<0.05	<0.05	<0.05	0.06	0.06	<0.05	<0.05	<0.05	<0.05	<0.05
$NH_3 + NH_4$		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.13	<0.10	<0.10	<0.10	0.14	<0.10	0.07	<0.10
P (ortho)		0.03	<0.01	<0.01	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.04
Site 009 - Adjacent to Proposed Project															
Flow (cfs)		-	-	-	11	-	-	216	162	-	-	-	-	-	-
pH	6.5-9	7.8	8.0	8.0	7.2	8.1	7.9	7.7	7.6	7.9	8.1	8.1	7.8	8.25	8.1
TDS	250 mg/l	64	47	64	57	62	60	36	35	32	59	64	86	69	
TSS	narrative	1	1	32	36	14	5	11	3	6	-	6	3	10	4
As	0.05 mg/l	0.015	0.013	0.02	0.018	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.012	0.008	0.012	0.013
Cn	0.005 mg/l							<0.005							
Fe	0.03 mg/l	0.09	0.07	0.09	0.04	0.12	0.06	0.11	0.08	<0.03	0.04	0.11	0.07	0.05	0.06
Mn	0.05 mg/l							<0.01			<0.02				
SO_4	250	7	7	5	6	3	3	2	2	2	4	[illegible]	7	7	
NO_x	10 mg/l	0.05	0.11	0.08	0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	0.05	<0.05	0.05
$NH_3 + NH_4$		0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.13	<0.10	0.24	0.18
P (ortho)		0.02	0.01	0.02	0.03	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01	0.03

Site 006 - At Mouth of Bear Creek

Flow (cfs)		9	7	14	14	82	97	194	145	89	17	11	8	11	-
pH	6.5-9	7.9	8.4	7.8	7.8	7.6	7.2	8.0	7.7	7.4	8.0	8.3	8.2	8.2	7.8
TDS	250 mg/l	113	98	102	90	64	86	37	23	38	98	127	155	124	90
TSS	narrative	1	2	2	13	13	7	1	1	7	1	3	5	6	4
As	0.05 mg/l	0.021	0.019	0.024	0.032	0.007	<0.005	<0.005	<0.005	0.008	0.014	0.027	0.019	0.022	0.022
Cn	0.005 mg/l							<0.005							
Fe	0.3 mg/l	0.03	0.03	<0.03	<0.03	0.12	0.09	0.11	0.07	<0.03	0.03	<0.03	<0.03	0.04	<0.03
Mn	0.05 mg/l							<0.02			<0.02				
SO_4	250	22	22	18	17	5	4	3	3	5	15	23	32	26	20
NO_x	10 mg/l	0.12	0.18	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05
$NH_3 + NH_4$		0.10	0.10	0.12	<0.10	0.20	0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	0.27	<0.10
P (ortho)		0.02	0.01	0.05	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.03

Source: Project application, 1984.

*Metals concentration represent dissolved fraction only.

**Samples taken between April 1981 and March 1982.

Table II-7: Water Quality Criteria Matrix (milligrams per liter unless otherwise noted)

	Cold water aquatic life (mg/l)	Public water supplies (mg/l)	Primary contact recreation (mg/l)	Irrigation (mg/l)	Livestock watering (mg/l)
Dissolved oxygen	7.0				
Fecal coliforms (per 100 ml)			200.0	1000.0	
Nitrite as N	0.05	1.0			10.0
Nitrate as N		10.0			
Nitrite and nitrate as N		10.0			100.0
Total ammonia		0.5			
Un-ionized ammonia	0.03				
Total inorganic N	1.00				
Total phosphorus	0.10		0.10		
Total dissolved solids		500.0		1200.0	10,000.0
Conductance (mircomhos/cm)				1800.0	
Turbidity (NTU)	10.0				
Total suspended solids	30.0				
Chloride		250.0		700.0	
Sulfate		250.0			
Cyanide	0.005	0.2			
Magnesium				160.0	
Sodium				160.0	
Sodium adsorption ratio				5.0	
Fluoride		2.4		15.0	2.0
Arsenic	0.44	0.05		0.10	0.20
Barium		1.00			
Boron				0.75	5.00
Chromium VI	0.021	0.05		1.00	
Iron	1.0	0.3		20.0	
Manganese		0.05		10.0	
Selenium	0.26	0.01		0.02	0.05
Mercury	0.004	0.002			0.010
Temperature (C)	19.4				
Temperature (F)	67.0				
Copper	**	1.0		5.0	0.5
Lead	**	0.05		10.0	0.10
Zinc	**	5.0		10.0	25.0
Cadmium	**	0.01		0.05	0.05
Chromium III	**	17.8			
Nickel	**	0.015		2.0	
Silver	**	0.05			
pH (minimum)	6.5	6.5	6.5	4.5	
pH (maximum)	8.5	8.5	8.5	9.0	

Source: Montana Department of Health and Environmental Sciences, 1984.

**Specific criteria for the protection of aquatic life are based on water hardness.

Bear Creek was sampled by Westech for cyanide once during spring high runoff in June, 1981; no cyanide was detected. The USGS indicates that cyanide has never been detected in the Yellowstone River (USGS, 1971).

Ground Water

The foundation materials at the site of the proposed tailings dump consist of Quarternary sediments overlying Precambrian metamorphic rocks. Drilling of monitoring wells in the proposed tailings area by Westech shows bedrock to be as much as 300 feet below the surface of the terrace deposits, or about 50 feet below the level of Bear Creek (Steffen Robertson and Kirsten, 1984).

Glacial tills cover bedrock on most of the surrounding hillsides and are the oldest deposits at the site. Sediments overlying the till in the area of the proposed impoundment consist of two sequences. The lower sequence is one of bedded clays, silts, and fine sands. Above the fine-grained sediment is about 100 feet of coarse-grained sands and gravels.

The water table appears to coincide with the intersection of the coarser- and finer-grained sediments at a depth of about 100 to 150 feet. Perched water is also found above layers of silts and clays and is most likely associated with seepage from the historic tailings impoundment (Steffen Robertson and Kirsten, 1984). A simplified cross section through the proposed tailings site was presented in figure II-3.

The movement of water in the project area is downgradient from Mineral Hill towards Bear Creek at about 0.25 feet per foot through bedrock and 0.10 feet per foot through glacial deposits (project application, 1984). Bedrock hydraulic conductivity is assumed to be 1×10^{-4} feet per day. Hydraulic conductivities in the assorted glacial deposits range between 1×10^{3} feet per day in clean sands and gravels to 1×10^{-3} feet per day in silts and clays, or mixtures of sand, silt, and clay (U.S.D.I. Bureau of Reclamation, 1977). Using Darcy's law, it has been estimated that water moves through bedrock at about 2.5×10^{-5} feet per day and up to 100 feet per day in sands and gravels. Wells tapping sandy and gravelly zones in the project area can produce more than 200 gallons per minute with an 8-hour specific capacity of 6 gallons per minute per foot of drawdown.

Analysis of the ground water system suggests there is a hydraulic connection between the bedrock aquifer below the proposed mine workings and the alluvial deposits in the vicinity of Bear Creek (project application, 1984). Although percolation through the existing mines is probably greatest during snowmelt periods, the contribution of water from bedrock to the alluvial system is considered to be small (Darrel Dunn, consulting geologist, pers. comm., 1985).

Claims for existing uses of ground water filed with the Montana Department of Natural Resources and Conservation (DNRC) are summarized in table II-8. The applicant has filed water rights claims for 224 gallons per minute of ground water in township 9 south, range 9 east, section 9 for mining purposes; the priority date claimed is 1898.

Table II-8: Existing Ground Water Claims in Bear Creek Basin

Current owner	Location of well	Maximum flow rate	Remarks
U.S. Forest Service	T9S-R9E-S4	45 gpm	Upgradient of project
Denise L. Harms	T9S-R9E-S8	12 gpm	
Oliver Wormsbecker	T9S-R9E-S8	40 gpm	Unaffected by project
George and Viola Athas	T9S-R9E-S8	16 gpm	Unaffected by project
Louise Foster	T9S-R9E-S9	20 gpm	
Homestake Mining Company	T9S-R9E-S9	224 gpm	Priority date--1898 Use--mining
Crevasse Mountain Mining Company	T9S-R9E-S11	666 gpm	Use--mining
Crevasse Mountain Mining Company	T9S-R9E-S22	1,571 gpm	Use--mining
Raymond Opperman	T9S-R9E-S11	10 gpm	
Richard Blankenship	T9S-R9E-S22	5 gpm	Unaffected by project

Source: Montana Department of Natural Resources and Conservation, 1985.

Ground water samples were analyzed from seven wells located near the proposed tailings dump site, one well near the proposed mill site, and one well downgradient of the existing tailings site near the Jardine bridge. Water samples have been collected quarterly since July 1984. Well locations are identified in figure II-6.

Ground water quality in the project area is calcium carbonate type with values of pH ranging from 6.8 to 7.8. Concentrations of heavy metals, arsenic, and cyanide appear elevated. Table II-9 presents selected ground water quality data that characterize the impact that past mining activities have had on the quality of water near the existing small tailings impoundment. Poor-quality water from the alluvial aquifer enters Bear Creek and is eventually diluted.

AQUATICS

Aquatic macroinvertebrates and algae were collected at seven sites (figure II-7) in April (before spring runoff), August (after spring runoff), and November (during fall low flow) of 1981. The aquatic biota in Bear Creek are indicative of good-quality surface waters.

Macroinvertebrate

Insects were collected using the unit-effort-traveling-kick method. More than 90 percent of the total insect population at all stations consisted of

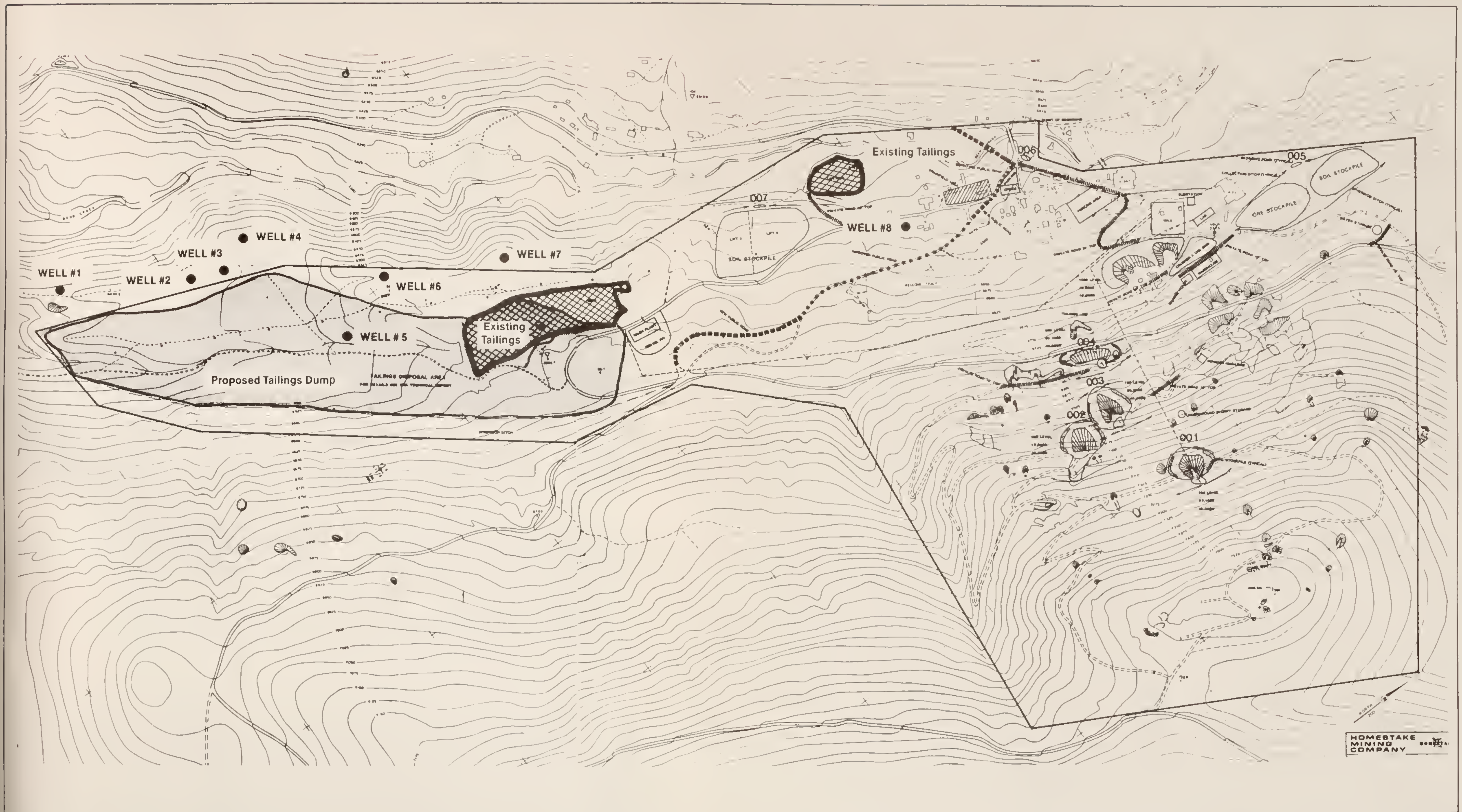

Figure II-6: Ground water samples were analyzed from seven wells. These wells would monitor the water quality in the aquifer below the proposed tailings dump.

Table II-9: Maximum Recorded Concentrations of Selected Ground Water Quality Constituents

	EPA criteria (mg/l)	At proposed tailings site	At proposed mill site	Downgradient of old tailings**
Cyanide	0.2	0.136(T)	0.006(T)	*
Arsenic	0.05	0.13	0.081	130.0(T)
Manganese	0.05	0.63	0.58	4.93(T)
Iron	0.3	0.80	0.28	740.0(T)
Lead	0.05	0.01	0.02	0.13(T)
Mercury	0.002	<0.001	<0.001	0.026(T)

Source: Project application, 1984..
All concentrations represent dissolved fraction unless otherwise indicated.
(T) = Total
* No sample taken.
**Special water analysis by Western Technology on January 27, 1981.

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stoneflies (Plecoptera), mayflies (Ephemeroptera), and caddisflies (Tricoptera). Fifty-nine individual taxa were identified, twenty-eight of which were common to all seven sampling sites. The number of taxa collected ranged from 41 at North Fork Bear Creek to 29 at Pine Creek. The sites on Bear Creek showed little variation in total number of taxa. Mean organism numbers per sample ranged from 290 organisms at site 008 to 175 organisms at site 001. The mayfly Rhithrogena robusta and stoneflies of the family Chloroperidae were the predominant organisms at all sampling stations. Relative abundance of taxa collected at each site is listed in appendix 1.

Unpolluted streams with favorable substrate, oxygen levels, and temperature generally produce a minimum of 15 genera depending on stream order and season of collection (DHES, 1981). Aquatic numbers in Bear Creek indicate unpolluted conditions despite the apparent contributions of sediment and metals from past mining activities.

Leeches (Hirudinea) were the only other macroinvertebrates collected; they were common at all sites.

Periphyton

Periphytic algae were collected from natural substrates at the same seven sites (figure II-7). As a water quality indicator, the diatoms (Bacillariophyta) are quite important. Bahls (1979) found that benthic diatom associations in unpolluted Montana streams usually had more than 25 species and a Shannon Weaver diversity index (Weber, 1973) greater than three. Total average diatom species present ranged from 36 (station 002) to 47 (station 009); average diversity indexes ranged from 3.85 (station 010) to 4.54 (station 009). Thus, Bear Creek provides good quality habitat for aquatic life. Some of the more abundant diatom species were Fragilaria vaucheriae, Cocconeis

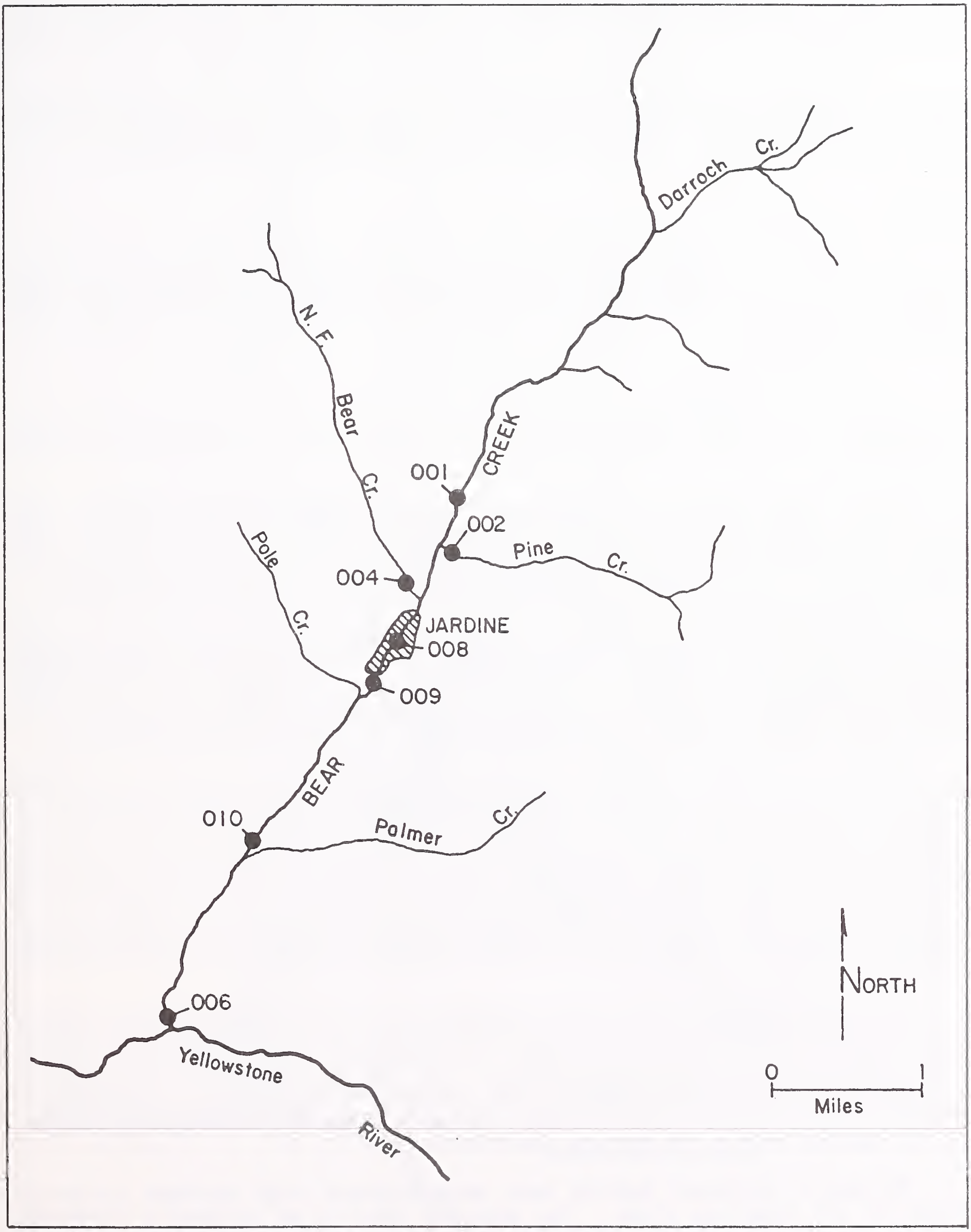

Figure II-7: Aquatic macroinvertebrates and algae were collected at seven sites in April, August, and November of 1981.

placentula, and Rhoicosphenia curvata. A complete species listing and percent relative abundance table is available at the Montana Department of State Lands (project application, 1984).

In addition to the diatoms, 15 genera of green algae (Chlorophyta), 10 genera of blue-green algae (Cyanophyta), four genera of yellow-green algae (Chrysophyta), and two genera of red algae (Rhodophyta) were collected.

Aquatic Macrophytes

No aquatic macrophytes (higher plants) were observed during the survey. The habitat is not conducive to their survival because Bear Creek is a low-order, cascading stream with few pools and a coarse gravel, cobble, and boulder substrate.

FISHERIES

Bear Creek supports a relatively diverse and abundant sport fishery. The fishery is comprised mostly of rainbow trout x cutthroat trout hybrids, and pure Yellowstone cutthroat trout. Rainbow trout, brown trout, and mountain whitefish are less abundant. No nongame species were captured or observed.

Fish populations were sampled with a bank electrofishing unit (Oswald in: project application, 1984) at three primary sites on Bear Creek. Five species of game fish were caught: cutthroat trout (Salmo clarki), rainbow trout (Salmo gairdneri), rainbow x cutthroat hybrids (S. gairdneri x S. clarki), brown trout (Salmo trutta), and mountain whitefish (Prosopium williamsoni).

Bear Creek supports both migrant and resident populations of cutthroat trout. Migrating cutthroat trout were captured only at the Powerhouse section (figure II-8) and the migration appears to have peaked during early July. Spawning occurred between July 9 and July 22, 1981. Although only 19 migrants were captured, this total is greater than that captured in eight of the nine tributaries studied by Berg (1975) for three years. Only Cedar Creek, with 20 fish per year, was greater. Thus, lower Bear Creek appears to support substantial cutthroat spawning migration in relation to other nearby Yellowstone tributaries (Oswald, 1982).

Resident cutthroat trout were captured in all sampling sections of Bear Creek, but most often in the upstream trail section. These resident cutthroat trout were the pure Yellowstone strain, a species of "special concern" determined by the Montana Department of Fish, Wildlife, and Parks. Although this designation has no legal implications, it does indicate concern for the future of the species within its Montana distribution.

Rainbow x cutthroat hybrids were more abundant than resident cutthroat trout at all sampling sites. The measured density of rainbow x cutthroat hybrids ranged from 65-151 per 1,000 feet (total biomass of 8-27 pounds per 1,000 feet) compared to the highest density of cutthroat trout of 42 per 1,000

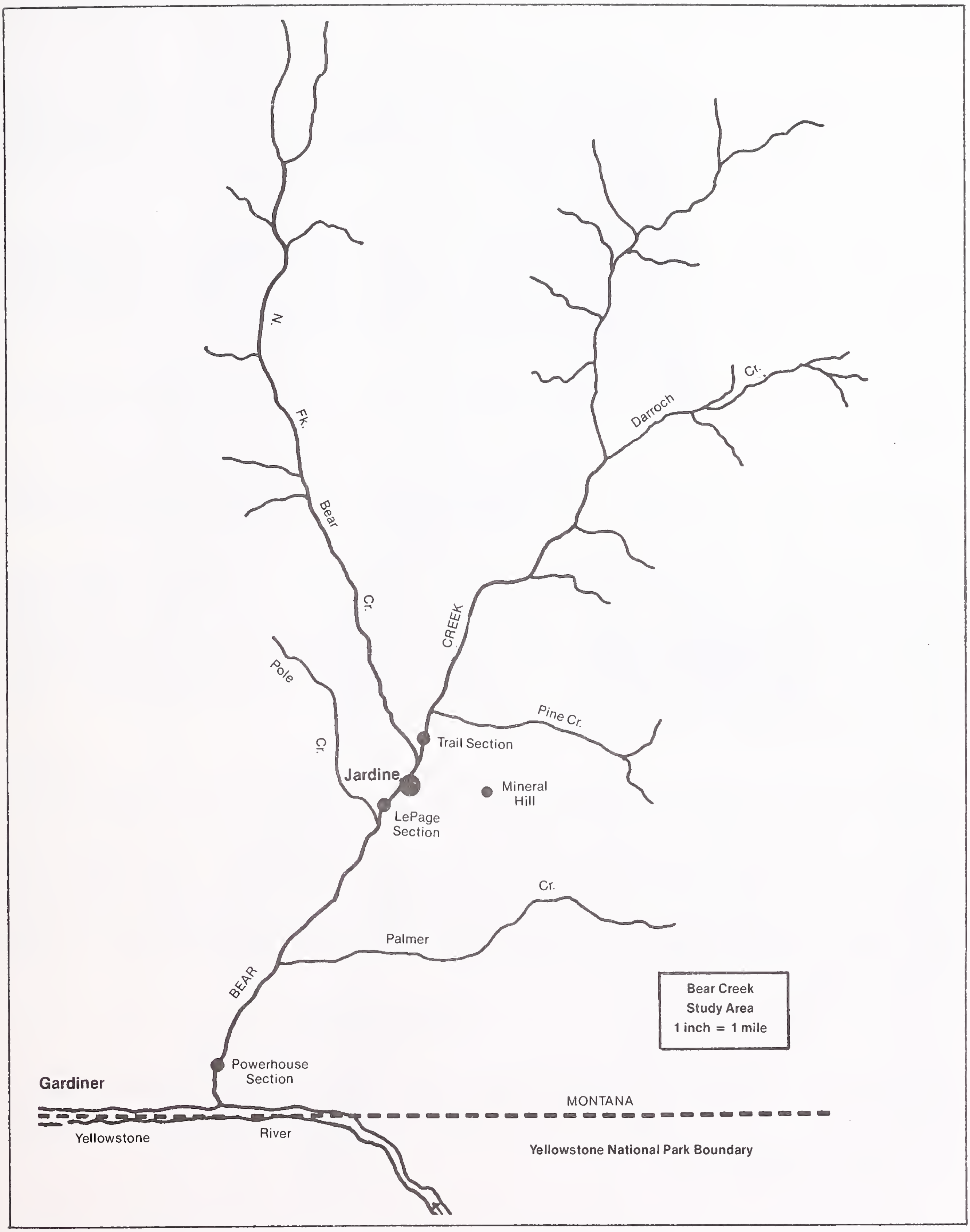

Figure II-8: Fish populations were sampled with a bank electrofishing unit at three primary sites on Bear Creek.

feet (total biomass nine pounds per 1,000 feet). These hybrids may have originated when Bear Creek was stocked with 2,050 catchable rainbow trout in 1958.

Rainbow trout were collected infrequently at all sampling areas; brown trout and mountain whitefish were collected in small numbers only at the Powerhouse section. No migrating brown trout were collected. If mountain whitefish spawned in Bear Creek, their migration was limited to the extreme lower portion of the stream.

Numbers of game fish per 1,000 feet of stream increased downstream. However, the greatest biomass of fish was in the LePage section, immediately downstream from Jardine. Perhaps this increase is due to higher productivity of Bear Creek caused by nutrient loading from septic systems or limited fishing pressure on the private land adjacent to this section of stream.

SOILS

The Jardine Joint Venture soil survey covers about 2,500 acres in and around the town of Jardine. This area includes the 410-acre proposed permit area and the 93-acre proposed disturbance area.

The soils of the proposed permit area vary widely in depth, color, profile morphology, drainage characteristics, organic matter content, and trace element concentrations. This diversity reflects the variability of topography, parent materials, vegetation, past land use practices, and disturbances. In general, the soils are naturally acidic, coarse textured (with few exceptions), and frequently have a coarse fragment content (gravels or cobbles) greater than 25 percent by volume.

Within the proposed permit area, a total of 10 soil series (including phases) have been identified and placed into 10 mapping units. (The soils in this survey were named using letters of the alphabet to avoid any potential conflict with official Soil Conservation Service soil series names.) In addition, a "disturbed" mapping unit was used to identify areas where the natural soils have been disturbed by past mining and other related activities. For ease of discussion, the soil mapping units have been placed into four major soil groups, based on similarities in parent material and, to some extent, topographical position:

- --Alluvial soils
- --Colluvial soils
- --Glacial soils
- --Alluvial/glacial soils

The location of these soil groups within the proposed permit area is shown in figure II-9. For a complete list of the mapping units proposed for disturbance, as well as the amount of soil by unit proposed for salvage, see Chapter III--Soils, table III-6.

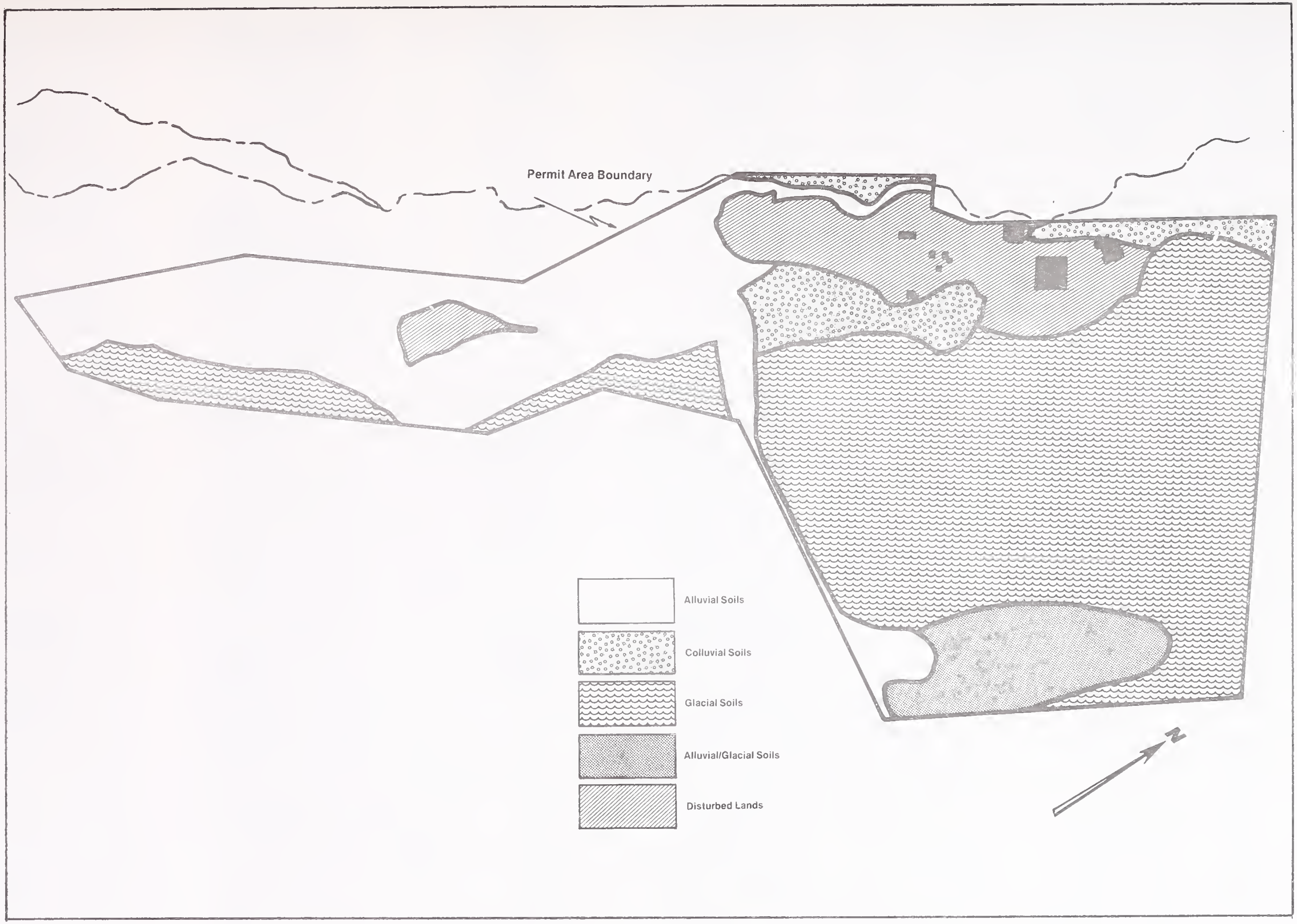

Figure II-9: Soil mapping units in the project area have been placed into four major soil groups: alluvial, colluvial, glacial, and alluvial/glacial soils. In addition, a unit was used to identify areas where the natural soils have been disturbed by post-mining and related activities.

Alluvial Soils

The alluvial soils group covers about 26 percent of the proposed permit area and about half of the proposed disturbance area. The group includes both shallow and deep soils that developed in alluvium (water-deposited material).

The soils in this group vary somewhat in physical and chemical characteristics and degree of soil development. The individual soil characteristics are determined largely by the original source of the water-deposited materials, the degree to which these materials were sorted, and the local microenvironment in which the soils developed.

Type B and Est soils are the shallow soils in this group; type E and M soils are deep. The predominant soil texture in the group is gravelly sandy loam; however, textures range from loam to gravelly sand. The coarse fragment content ranges from 14 to 73 percent by volume and generally increases with depth. The pH of these soils ranges from 5.0 (strongly acid) to 6.7 (near neutral). Trace element concentrations are generally within acceptable ranges, although aluminum and arsenic levels are elevated in some soil horizons within this group.

Most of the alluvial soils are found along the west side of the permit area, with the remainder occurring in an east-west drainage on the southwest side of Mineral Hill. Plant species commonly associated with this soils group include Engelmann spruce, Douglas-fir, big sagebrush, Idaho fescue, bluebunch wheatgrass, twinflower, sweet-scented bedstraw, starry Solomon's seal, arrowleaf balsamroot, lupine, and sticky geranium.

Colluvial Soils

The colluvial soils group consists of only one soil type--the S series--which occurs in three segments in the northwest part of the permit area (figure II-9). This soil covers about 6 percent of the proposed permit area and about 2 percent of the proposed disturbance area. The S soil is a shallow, very gravelly, sandy loam soil that formed in colluvium--material that has moved downhill and accumulated at the base of steep slopes as a result of gravity.

The coarse fragment content of the S soil ranges between 20 and 40 percent by volume, and increases with depth. The pH of this soil ranges from 5.1 (strongly acid) to 5.8 (medium acid). Trace element concentrations are within acceptable ranges with the exception of aluminum, which is elevated in all samples. The most common vegetation on this soil is Douglas-fir, Idaho fescue, bluebunch wheatgrass, big sagebrush, milkvetch, and phlox.

Glacial Soils

Glacial soils cover about half of the proposed permit area and about 17 percent of the disturbance area. This group is located in the northern and eastern sections of the permit area (figure II-9). The group consists of moderately deep to deep soils that formed in glacial till (unstratified material deposited by glaciers).

Included in this group are the A, A1, and F soils. Soil textures range from gravelly loams to very gravelly sandy loams. The A and F soils range between 25 and 60 percent coarse fragments; the A1 soils generally have less fragments, with a range between 15 and 20 percent. As with the other soil groups, coarse fragment content increases with depth. The pH of the soils in this group ranges from 4.7 (very strongly acid) to 7.9 (moderately alkaline). Trace element concentrations are low, with the exception of elevated aluminum in one sample of the F soil. Vegetation associated with these soils at lower elevations includes Douglas-fir, pinegrass, common snowberry, big sagebrush, Idaho fescue, and bluebunch wheatgrass. At higher elevations, the vegetation includes subalpine fir, Engelmann spruce, lodgepole pine, whitebark pine, twinflower, arnica, and aster.

Alluvial/Glacial Soils

The alluvial/glacial soils formed in alluvium deposited over glacial till. This soils group consists of deep soils, and covers about 6 percent of the permit area. Although this group is found in the permit area, it would not be disturbed by the proposed operation. The group consists of the D and G soils, which are located to the south and east of the summit of Mineral Hill (figure II-9). The soils in this group are poorly drained, which indicates that they have a water table near the soil surface. Soil textures vary from cobbly and fine gravelly loams to silt loams. Coarse fragment content ranges from less than 10 to 40 percent by volume, and increases with depth. The pH range of these soils is between 5.0 (strongly acid) and 6.7 (near neutral). With the exception of aluminum levels elevated in two samples of the G soil, trace element concentrations are low.

Plant species associated with this soil group include timothy grass, sedges, strawberry, larkspur, lupine, prairie smoke, and sticky geranium in the wetter areas; the drier areas include big sagebrush, Idaho fescue, and bluebunch wheatgrass along with a moderate forb cover.

Disturbed Area

Disturbed areas occupy about 11 percent of the proposed permit area and about 28 percent of the proposed disturbance area. This mapping unit was used to map such areas as roads, old tailings ponds, the old mill and other facility areas, and the disturbances within the Jardine townsite (houses, barns, corrals, pastures, etc.). Within this disturbance area are some soils that may be suitable for salvage, but occur in such small areas that they could not be individually delineated on the map. Some of these soils may be high in trace-element concentrations because they are near disturbed areas.

VEGETATION

The 1,514-acre vegetation study area included the proposed permit area. Eleven vegetation types were identified during 1981 baseline surveys (Westech,

1982). The big sagebrush/Idaho fescue, big sagebrush/Douglas-fir, and Douglas-fir/common snowberry types make up 84 percent of the study area (table II-10). (See appendix 4 for scientific names).

A total of 326 plant species were identified during the field study. The greatest number of species were found in the big sagebrush/Idaho fescue vegetation type (table II-10). No threatened or endangered plant species (Ayensu and DeFillips, 1978) or rare plants (Lesica et al., 1984) were discovered in the study area.

Based on Soil Conservation Service methods (1977, 1981), most rangeland--nonforested and undisturbed areas--in the study area is in good condition (50 to 75 percent of climax). However, livestock grazing is prohibited on the National Forest lands that constitute over half of the study area. The only grazing lands that would be affected by mining are horse pastures within the proposed permit area (project application, 1984).

Descriptions of Vegetation Types

(1) Idaho fescue/bluebunch wheatgrass. Idaho fescue, constituting 21 percent of the vegetation cover, is the dominant grass in this type. Bluebunch wheatgrass and prairie junegrass are the other common grasses. Perennial grasses

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Table II-10: Vegetation Types and Number of Species In the Jardine Vegetation Study Area May-August, 1981

		No. of species recorded	No. of sampling transects	Study area		Disturbance area	
	Vegetation type			acres	percent	acres	percent
(1)	Idaho fescue/bluebunch wheatgrass	63	5	9	1	0	0
(2)	Big sagebrush/Idaho fescue	90	7	489	32	39	42
(3)	Burned big sagebrush	53	3	9	1	0	0
(4)	Big sagebrush/Douglas-fir	77	5	421	28	19	20
(5)	Douglas-fir/common snowberry	80	8	368	24	9	10
(6)	Douglas-fir/pinegrass	53	3	40	3	-	-
(7)	Engelmann spruce	27[2]	4	47	3	-	-
(8)	Subalpine fir	33[2]	5	-[1]	-	0	0
(9)	Quaking aspen	75	5	45	3	0	0
(10)	Disturbance	0	0	67	4	26	28
(11)	Pasture	0	0	19	1	0	0
	TOTAL	326[3]	45	1,514	100	93	100

Source: Westech, 1982.

[1] Less than 1 percent or 1 acre.

[2] Determined by averaging subtypes (see text).

[3] The same species were often recorded in more than one type, therefore, the column does not total 326 (see text).

account for 57 percent of total annual production (table II-11). Forbs make up 30 percent of the vegetation cover with silky lupine, many-flowered phlox, and rose pussytoes occurring most often. Shrubs, primarily big sagebrush and green rabbitbrush, also contribute to the vegetational composition (table II-12).

(2) Big sagebrush/Idaho fescue. The dominant understory plant in this type is Idaho fescue. Bluebunch wheatgrass and prairie junegrass are commonly found. Forbs, notably arrowleaf balsamroot, weedy milkvetch, and thickstem aster, are intermixed with the grasses. Total production is estimated at 1,138 pounds/acre/year. The shrub overstory is almost entirely big sagebrush.

(3) Burned big sagebrush. Prescribed burning from 1976 through 1978 stimulated the growth of perennial grasses in areas formerly dominated by sagebrush. Total grass cover is 73 percent, much higher than the 43 percent cover reported for the Idaho fescue/bluebunch wheatgrass type. Production also responded positively to burning. Burned areas have 2-1/2 times the herbaceous production of unburned big sagebrush/Idaho fescue type. The most abundant grass is Columbia needlegrass. Bluebunch wheatgrass and Idaho fescue are the next most common grasses. Kentucky bluegrass is invading the burned sites. Burning has apparently increased forb cover, which is 26 percent higher than in unburned grasslands. Dominant forbs are arrowleaf balsamroot, sulfur buckwheat, and yarrow. Green rabbitbrush is the only readily noticeable shrub species.

(4) Big sagebrush/Douglas-fir. This vegetation type may be an extensive ecotone between the Douglas-fir vegetation types and the big sagebrush/Idaho fescue type. As such, vegetation is similar in composition to the big sagebrush/Idaho fescue type. The major difference is the presence of invading Douglas-fir. Dominant grasses are Idaho fescue, bluebunch wheatgrass, and prairie junegrass. Forbs growing among the grasses include arrowleaf balsamroot and sticky geranium. Big sagebrush contributes most of the shrub cover.

(5) Douglas-fir/common snowberry. The overstory of this vegetation type is dominated by Douglas-fir. At higher elevations, lodgepole pine is a minor species. Below the trees, common snowberry and shiny-leaf spirea form a canopy cover of 18 percent. Vegetation of the forest floor is dominated by pinegrass. The most prevalent forbs are western meadowrue and showy aster.

(6) Douglas-fir/pinegrass. This forest type is dominated by Douglas-fir, which forms a canopy cover of 69 percent and occurs at 298 trees/acre. Shrub cover is only 2 percent. The most common shrubs are shiny-leaf spirea and snowberry. Pinegrass, followed by Idaho fescue and fowl bluegrass, are the dominant grasses. Forbs are more abundant than in the Douglas-fir/common snowberry type. Over half the forb cover is due to showy aster and weedy milkvetch.

(7) Engelmann spruce. In the study area, Engelmann spruce is restricted to stream bottoms and adjacent slopes. The Engelmann spruce type has been divided into Engelmann spruce/common horsetail, Engelmann spruce/sweetscented bedstraw, Engelmann spruce/twinflower, and Engelmann spruce/starry Solomon's seal subtypes.

Table II-11: Estimated Annual Production by Vegetation Type Jardine Vegetation Study Area May-August, 1981 (in pounds of dry matter per acre per year)

	Vegetation Type								
Plant group	Idaho fescue/ bluebunch wheatgrass	Big sagebrush/ Idaho fescue	Burned big sagebrush	Big sagebrush/ Douglas-fir	Douglas-fir/ snowberry	Douglas-fir/ pinegrass	Engelmann spruce[1]	Subalpine fir	Quaking aspen
Perennial grasses and sedges	550	510	1,372	540	106	136	18	24	210
Forbs	353	253	665	334	212	240	153	206	514
Shrubs	61	375	0	231	66	5	186	69	197
TOTAL	964	1,138	2,037	1,105	384	381	357	299	921

Source: Westech, 1982.

[1] Production determined by averaging data from four subtypes (see text).

Table II-12: Average Tree and Shrub Density (number/acre) by Vegetation Type Jardine Vegetation Study Area May-August, 1981

	Vegetation Types With Tree Density Measurements					
	Big sagebrush Douglas-fir	Douglas-fir/ common snowberry	Douglas-fir/ pinegrass	Engelmann spruce	Subalpine fir	Quaking aspen
Tree Species						
Douglas-fir	75	282	298	106	161	22
Lodgepole pine	0	14	0	14	128	0
Engelmann spruce	0	3	0	366	123	0
Subalpine fir	0	0	0	0	515	0
Whitebark pine	0	9	0	0	77	0
Limber pine	1	0	0	0	0	16
Quaking aspen	1	11	5	0	0	1,136
Other species	0	0	0	43	0	0

	Vegetation types with shrub density measurements		
	Idaho fescue/ Bluebunch Wheatgrass	Big Sagebrush/ Idaho Fescue	Big Sagebrush/ Douglas-fir
Shrub Species			
Big sagebrush	462	4,552	3,968
Rubber rabbitbrush	178	87	40
Green rabbitbrush	753	87	0
Prairie rose	65	0	0
Woods rose	0	0	8
Common snowberry	32	0	291
Horsebrush	146	40	0

Source: Westech, 1982.

When Engelmann spruce grows in particularly moist areas, common horsetail is the major understory species. Prickly rose, Rocky Mountain juniper, and shiny-leaf spirea grow over the horsetail.

Douglas-fir is more abundant than Engelmann spruce in the overstory of the sweetscented bedstraw subtype. Important shrubs are shiny-leaf spirea, common snowberry, and Wood's rose. Total forb coverage is high (62 percent) and includes western meadowrue and fireweed. Pinegrass grows among the forbs. Although sweetscented bedstraw identifies the subtype, it adds only 1 percent to the vegetation cover.

The twinflower subtype is characterized by an overstory of Engelmann spruce, Douglas-fir, and lodgepole pine. Blue huckleberry and thimbleberry are important shrubs. Pinegrass is the only major grass and occurs with the forbs twinflower and heartleaf arnica.

The starry Solomon's seal subtype is found on relatively dry sites. Douglas-fir and Engelmann spruce are the most abundant trees. Snowberry is a common shrub. The only significant grass is mountain brome, which is mixed with showy aster and western meadowrue.

(8) Subalpine fir. The subalpine fir type exists as two subtypes--subalpine fir/sweetscented bedstraw and subalpine fir/twinflower. The sweetscented bedstraw subtype is found along Pine Creek. Engelmann spruce and subalpine fir are common trees. The shrub layer consists mostly of thimbleberry, smooth currant, and honeysuckle. Pinegrass is the only significant grass species. Forbs include western meadowrue, twinflower, and sweetscented bedstraw.

Subalpine fir forms most of the nearly closed canopy of the twinflower subtype. Other conifers, such as whitebark pine and lodgepole pine, grow among the subalpine fir. Honeysuckle is the only common shrub while pinegrass is the only common grass. Forbs, however, are more diverse and include twinflower, heartleaf arnica, and showy aster.

(9) Quaking aspen. Stands of aspen are found in moist sites adjacent to Douglas-fir forests. Aspen dominates the overstory with a cover of 68 percent. Douglas-fir is scattered among the aspen. The shrub cover is primarily common snowberry. Kentucky bluegrass and blue wildrye are frequently encountered grasses. The aspen type has a higher forb cover than any other type. Rocky Mountain helianthella, cow parsnip, and sticky geranium makes up most of the 64 percent forb cover.

(10) Disturbance. The disturbance type includes residences in Jardine and along the county road. Also included are areas disturbed by past mining activities. An abandoned mill is located just north of Jardine and waste rock dumps are scattered throughout the study area. Most of the disturbance area, however, is comprised of two tailings pond sites. The larger site is essentially void of vegetation, while grasses and clovers grow on the smaller site.

(11) Pasture. Several horse pastures are located within the study area. The dominant plants are Kentucky bluegrass, timothy, smooth brome, and clovers.

WILDLIFE

The Jardine wildlife study area (figure II-10) adjoins Yellowstone National Park and supports abundant and diverse wildlife populations. These populations were surveyed from May, 1981 through May, 1982 (Westech, 1984). During baseline surveys, 28 mammal, 106 bird, 3 reptile, and 1 amphibian species were recorded (appendix 3 lists scientific names of species discussed in the text). Important elk and mule deer winter ranges, together with traditional elk migration routes, lie within the study area.

The habitat requirements of the various animals are met by combinations of topography and vegetation types. Wildlife habitat types (table II-13) were based on existing vegetation and correspond to previously described vegetation types (see Chapter II--Vegetation). Due to mapping limitations, acreage of each type was estimated for only a portion (22,000 acres) of the entire study area (figure II-10). The lodgepole pine/subalpine fir and the big sagebrush/grassland types were the most prevalent types.

Elk

The study area lies within the traditional winter range of the Northern Yellowstone elk herd. This herd included roughly 12,000 animals in the mid 1970s (Houston, 1982), within the 10,000 to 15,000 animal carrying capacity estimated by Houston (1982). However, by 1982 the herd had grown to about 16,000 to 17,000 individuals (Mary Meagher, National Park Service, pers. comm. in Westech, 1984), exceeding Houston's carrying capacity estimate.

The northern part of Yellowstone National Park serves as summer range for the herd. More summer range is found north of the park, primarily in the Absaroka Beartooth wilderness (figure II-11) (Jon Swenson, Montana Department of Fish, Wildlife and Parks, pers. comm., April 17, 1985). About 83 percent of the winter range is within the park. The intensity and timing of elk migration varies year to year and is primarily influenced by weather. During mild winters 90 percent of the herd remains in the park (Houston, 1982). Erickson (1981) states that significant migrations to areas outside the park occurred in about 60 percent of the winters during the 1970s. However, since 1981, elk have moved out of the park in all winters (Tom Puchlerz, U.S. Forest Service, pers. comm., August 2, 1985). Migrating elk begin moving off high-elevation ranges in November. However, baseline surveys revealed that large numbers of elk do not inhabit the study area until January. Other studies (Craighead et al., 1972; Houston, 1982) indicate that significant herd use of the Jardine area begins in late December. Besides the Jardine area, the Northern Yellowstone herd uses additional winter range along the Yellowstone River (figure II-11). Many of these elk migrate through the study area as they follow traditional routes between Crevice Creek and Eagle Creek. Elk follow these routes and other back to summer ranges between early April and mid-May.

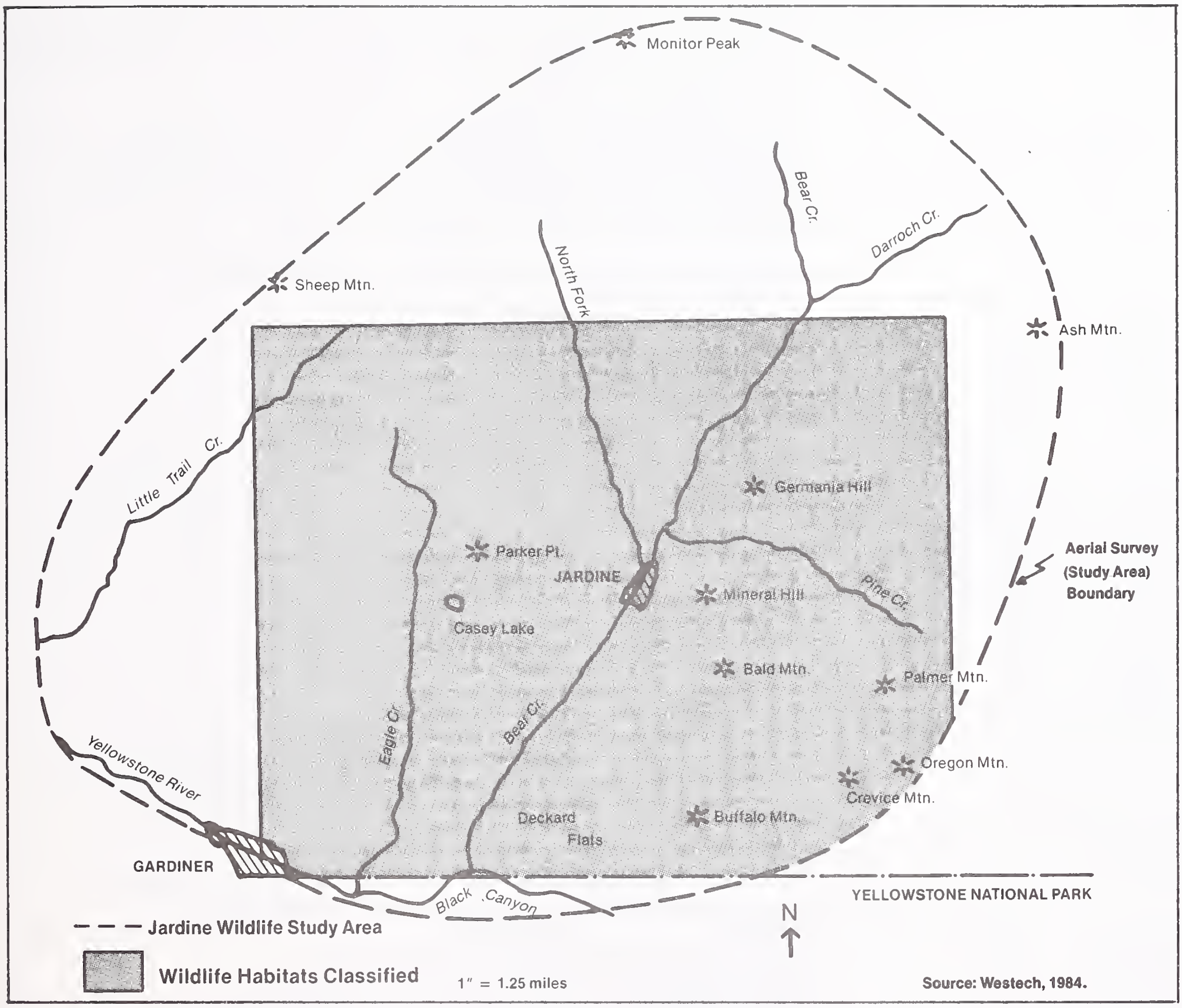


Figure II-10: The Jardine wildlife study area adjoins Yellowstone National Park and supports abundant and diverse wildlife populations.

The study area is also inhabited by an estimated 350 elk of the Monitor Peak-Ash Mountain herd. These elk spend summers in the Cedar Creek-Monitor Peak-Ash Mountain area. Although seasonal movements and winter ranges are not clearly defined, some animals probably move south to share winter range with the Northern Yellowstone herd.

Between May, 1981 and May, 1982, 561 observations totalling 16,373 elk were made in the study area. Only 46 of the observations were made during summer (June 16 to September 15). Twelve of these were repeated observations from agricultural lands near Gardiner. The other sightings indicated the presence of a small resident herd west of Parker Point and represented the

Table II-13: Wildlife Habitat Types and Corresponding Vegetation Types in the Jardine Wildlife Study Area

Wildlife habitat types	Acres	Percent of mapped study area[1]	Corresponding vegetation type
Creek bottom	290	1.3	Engelmann spruce Quaking aspen[2]
Limber pine/grass	53	0.2	--[3]
Aspen	607	2.8	Quaking aspen
Lodgepole pine/ subalpine fir	4,965	22.6	Subalpine fir
Douglas-fir/grass	2,834	12.9	Douglas-fir/pinegrass Douglas-fir/Idaho fescue
Douglas-fir/big sage	2,204	10.0	Big sagebrush/Douglas-fir
Douglas-fir/deciduous shrub	141	0.6	Douglas-fir/common snowberry
Douglas-fir/subalpine fir	3,311	15.1	Subalpine fir
Whitebark pine/ subalpine fir	620	2.8	Subalpine fir
Engelmann spruce/ subalpine fir	--[4]	--	Engelmann spruce
Big sage/grass	4,088	18.6	Big sagebrush/Idaho fescue Burned big sagebrush
Low sage/grass	--[4]	--	--[3]
Grassland	1,091	5.0	Idaho fescue/bluebunch wheatgrass
Alfalfa	90	0.4	--[3]
Disturbance	185	0.8	Disturbance
Clearcut	1,434	6.5	Subalpine fir
Scree/talus/cliff	86	0.4	--[3]
TOTALS	22,000	100	

Source: Westech, 1984.

[1]Accuracy of mapping estimated at ±15 percent; acreages and percentages by type are approximate.

[2]Also included areas dominated by cottonwood and willow that were not covered by the vegetation study.

[3]Not covered by vegetation study.

[4]Acreage not estimated.

Monitor Peak-Ash Mountain herd. The number of observations fell to 20 in autumn (September 16 to November 30). Elk were more randomly distributed in autumn than in summer, suggesting that they move to other ranges and avoid hunters.

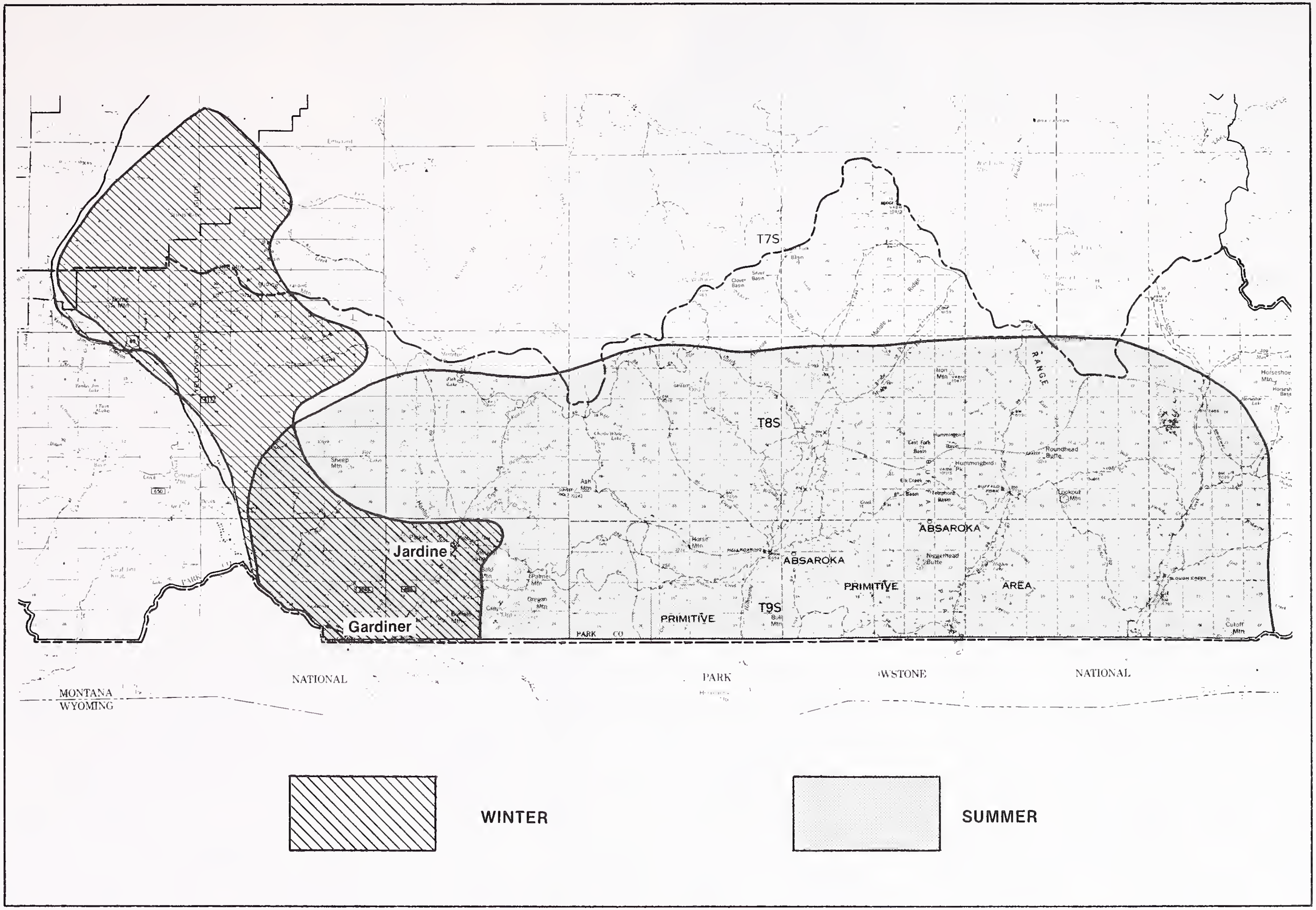


Figure II-11: Elk sighted in the Jardine study area may also use ranges in the Yellowstone River valley, Absaroka Mountains, and Yellowstone National Park. Source: Jon Swenson, Montana Department of Fish, Wildlife and Parks, pers. comm., April 17, 1985.

Observations increased sharply to 338 during winter (December 1 to March 31). Elk winter range included four concentration areas: Deckard Flats, Eagle Creek, Phelps Creek, and Little Trail Creek (figure II-12). Up to 1,500 elk were counted on Deckard Flats. Elk also used the adjacent slopes of Buffalo Mountain heavily. Late-season hunting appeared to force elk to seek security in the relatively inaccessible Little Trail Creek area. The 139 sightings made from April 1 to May 15, 1982, showed that spring range was similar to winter range. Observations of cow-calf group north and west of Parker Point support this area's previous designation as a calving ground (Johnson, 1981). By mid-May, most migratory elk had left the study area.

While in the study area, elk used mostly the big sage/grass, Douglas-fir/big sage, Douglas-fir/grass, and grassland habitat types (table II-14). The big sage/grass type was apparently preferred and accounted for 58 percent of winter observations. This type may also provide habitat for calving during spring.

In the Jardine area, elk apparently avoided areas with more than 2 feet of snow. Their winter range is characterized by a predominance of southerly aspects and moderately steep slopes (11 to 40 percent). These features tend to shed snow and provide a warmer environment. Generally, elk used steeper slopes during winter than they did during other seasons. The percentage of winter sightings on southerly aspects (60 percent of observations) was similar to the availability of those aspects (63 percent of winter range). West and northwest aspects, often having reduced snow depths due to wind action, accounted for about 35 percent of observations.

Winter range in the study area covers about 34 square miles. During a January 1982 aerial survey, 2,041 elk were counted on the winter range. This represents a minimum density of 58 elk per square mile. Actual density is probably higher, however, because not all elk could be seen during the count. The actual density was estimated at 66 elk per square mile.

Age ratios were not determined for the study area because calves could not be distinguished during winter aerial surveys. The sex ratio was estimated at 21 males per 100 females. This ratio, however, is not entirely accurate because some antlerless males were probably classified as females. Even so, the 21:100 ratio is considerably lower than the 31:100 ratio given by Houston (1982). This lower number of males in the study area may be due to a higher proportion of males remaining inside the park during winter. Hunting and poaching may also be reducing the number of males in the study area.

Ninety-six elk carcasses were found on the study area in spring 1982. Another 135 carcasses were counted in the Northern Yellowstone herd's winter range within the park. The relatively high count in the study area was probably due to the intensive searching. Also, elk weakened by over-winter malnutrition may have died while migrating through the study area towards the park. In addition to natural winter deaths, about 780 elk were harvested from the study area during the 1981-1982 late-season hunt. Late-season hunting appears to reduce the group size of migrating elk; it also interacts with weather to affect migratory movements. Some elk are also taken during the regular season. Seven incidents of poaching were recorded. Although not measured, natural predation contributed to overall mortality. Diseases were not noted.

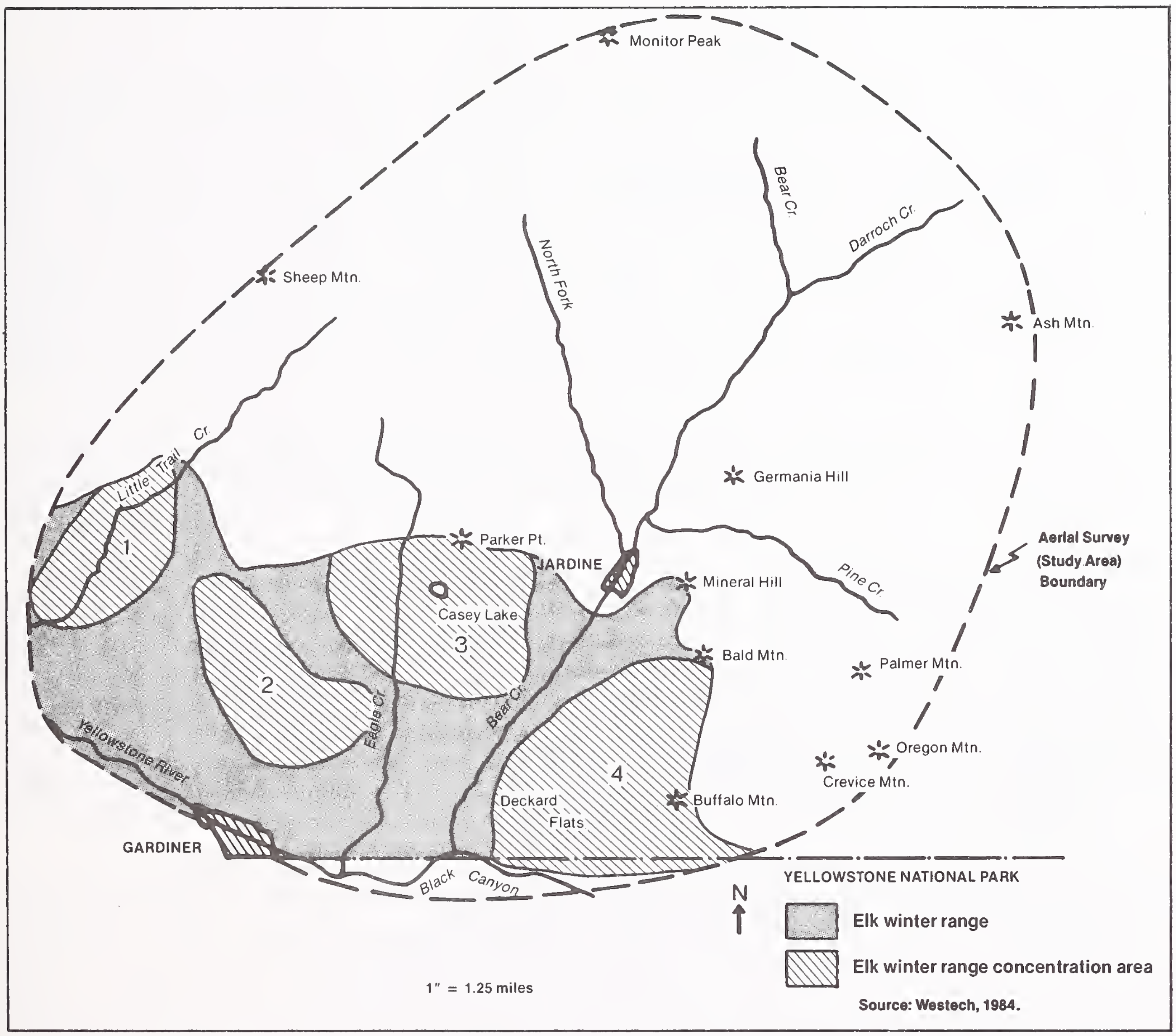


Figure II-12: Elk concentrate in certain areas in the winter.

Table II-14: Percentage of Elk Group Sightings by Habitat Type May 1981 to May 1982 Jardine Wildlife Study Area

	Habitat Type									
Month	Creek bottom	Aspen	Lodgepole/ subalpine fir	Douglas-fir/ grass	Douglas-fir/ big sage	Douglas-fir/ deciduous shrub	Douglas-fir/ subalpine fir	Whitebark pine/ subalpine fir	Big sage/ Grass	Grassland	Alfalfa
May 1981					40.0					60.0	
June				22.2					33.3	11.1	33.3
July			10.7	7.1					21.4	39.3	21.4
Aug								30.0	70.0		
Sept			10.0	20.0	40.0		10.0	20.0			
Oct				66.7		33.3					
Nov				100.0							
Dec				50.0	33.3					16.7	
Jan 1982	0.8	1.6		13.1	20.5	0.8			49.2	13.9	
Feb				9.6	17.6	0.9			66.4	5.6	
Mar		1.3		3.9	32.5				62.3		
Apr					16.1				83.9		
May		6.7			73.3				20.0		
Sample size (groups/ individuals)	1(1)	4(91)	4(6)	51(603)	115(2702)	4(15)	1(2)	5(20)	326(11833)	38(1056)	12(44)

Source: Westech, 1984.

Note: Percentages by month do not total 100 due to rounding. Blanks within the table indicate that no observations were made.

Mule Deer

Mule deer use the study area year-round. During summer, deer inhabit the area from Hellroaring Creek to Cinnabar Basin and Yellowstone National Park (figure II-13) (Jon Swenson, Montana Department of Fish, Wildlife and Parks, pers. comm., April 17, 1985). The winter population greatly increases as deer from Yellowstone National Park enter the area. Most of the estimated 2,000 deer in the park leave during severe winters. In contrast, mild winters encourage deer to remain. Houston (1982) reported that 65 percent of the winter range used by deer from the northern part of Yellowstone Park lies outside park boundaries along the Yellowstone River. Winter range along the Yellowstone River also receives a considerable influx of deer from summer ranges outside the park. Discernible migrations are not apparent.

On a year-round basis, mule deer were the most frequently observed species in the study area (761 observations totalling 3,866 deer); however, elk were observed in larger groups and were much more abundant during winter and early spring.

With the exception of low-elevation, open habitats, summer observations of mule deer were scattered throughout the study area (figure II-14). Autumn distribution was similar to summer distribution although deer had started using lower elevations. With the onset of winter many more deer entered the study area. Mule deer inhabited most of the elk winter range but were more restricted to lower elevations by snow. The few deer seen at higher altitudes were using paths or feeding sites previously made by elk. Early spring range (before May 15) was similar to winter range while by late spring the number of observations fell sharply to resemble the pattern of the previous summer.

On a year-round basis, deer depended primarily on the big sage/grass, Douglas-fir/big sage, and creek bottom habitat types (table II-15). The big sage/grass type was heavily used in the winter and may have been a preferred type. Big sage/grass lands also accounted for most spring observations. During summer and autumn, the deer remaining on the study area shifted to high-elevation forests; however, deer were more visible in open habitats and the big sage/grass type continued to contribute observations. Sixteen does with fawns were sighted in spring 1981. Although fawning occurred in the study area, specific sites were not identified.

Most winter observations of mule deer came from slopes of 11 to 30 percent. Unlike elk, deer did not show an increased use of steeper slopes during winter. The proportion of deer using southerly aspects (78 percent) was greater than the availability of those aspects (63 percent).

Although mule deer and elk used similar winter ranges, competition between the two species was not evident. The low levels of competition were probably due to the difference in habitat use. Compared to elk, mule deer used lower elevations, gentler slopes, and more southerly aspects. Deer did not depend on the windswept ridges and grasslands that were important to elk. Different foraging habitats further served to reduce competition (Houston, 1982).

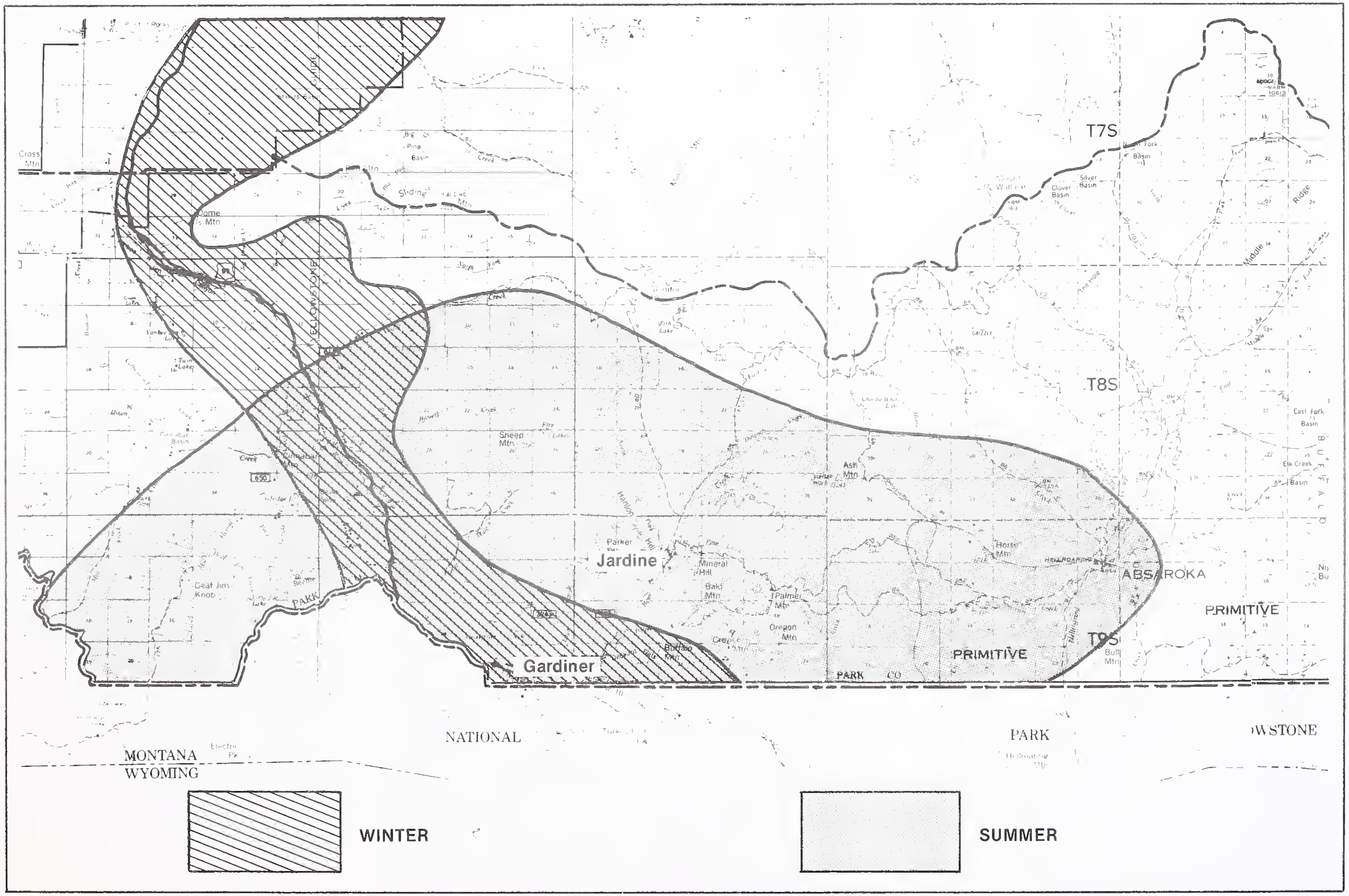


Figure II-13: Mule deer observed in the Jardine study area may also use ranges in the Yellowstone River valley, Absaroka and Gallatin Mountains, and Yellowstone National Park. Source: Jon Swenson, Montana Department of Fish, Wildlife and Parks, pers. comm., April 17, 1985, and Jerry T. Light, U.S. Forest Service, pers. comm., April 12, 1985.

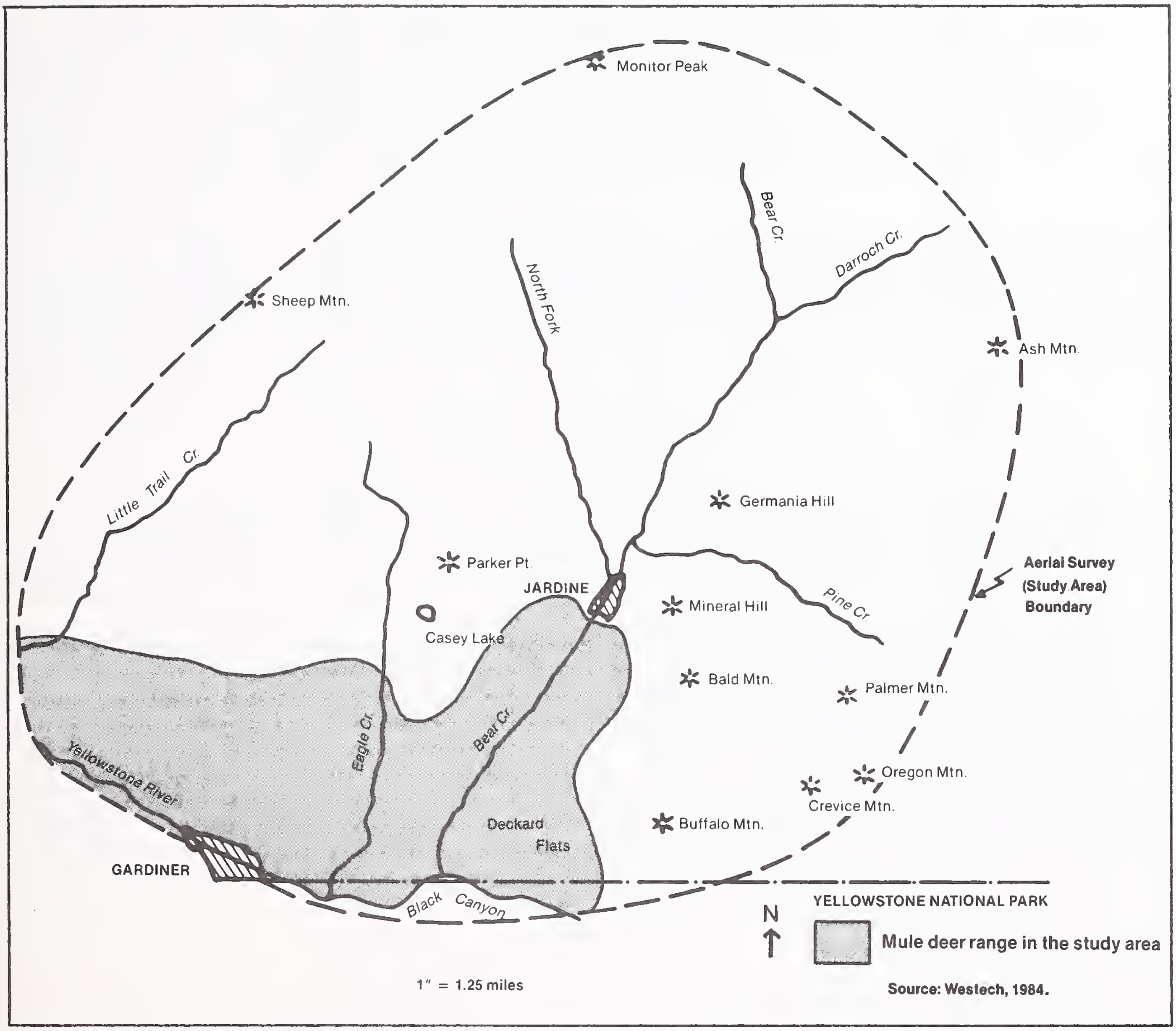


Figure II-14: During winter, mule deer use the area indicated by shading within the study area.

Table II-15: Percentage of Mule Deer Group Sighting by Habitat Type May 1981 through May 1982, Jardine Wildlife Study Area

	Habitat Type											
Month	Clearcut	Creek bottom	Limber pine/ Idaho fescue	Aspen	Lodgepole pine/ subalpine fir	Douglas-fir/ grass	Douglas-fir/ big sage	Douglas-fir/ deciduous shrub	Douglas-fir/ subalpine fir	Big sage/ grass	Grassland	Alfalfa
May 1981		5.1		6.8	3.4	1.7	28.8		1.7	49.1	3.4	
June	11.1	5.6		5.6	22.2	22.2	22.2			11.1		
July	7.7				11.5	19.2	15.4			26.9	19.2	
Aug	11.8	5.9			17.6	11.8	11.8		23.5	17.6		
Sept	21.7	8.7		17.4		21.7		17.4	8.7	4.3		
Oct	8.1	2.7		2.7	18.9	18.9	16.2	10.8	13.5	8.1		
Nov				12.5	12.5	25.0				50.0		
Dec		2.4					21.4	4.8		64.3	4.8	2.4
Jan 1982		8.2	3.6	2.7		4.5	20.0			60.0	0.9	
Feb		7.5	0.9				13.1			78.5		
Mar		1.3	0.6	0.6		0.6	6.3			90.6		
Apr		1.3					9.2			86.8		2.6
May		1.3					3.8			78.5		16.5
Sample size (groups/ individuals)	14(26)	30(104)	6(14)	11(44)	24(43)	27(56)	103(382)	6(14)	14(35)	499(2870)	11(33)	16(240)

Source: Westech, 1984

Note: Percentages by month do not total 100 due to rounding. Blanks within the table indicate that no observations were made.

Winter range in the study area covers about 20 square miles. In April, 1982, 180 deer (9 deer per square mile) were counted in this winter range; however, after adjustments were made to compensate for animals unobservable from the air, estimates of 29 to 30 deer per square mile were obtained. These figures are close to the density of 34.5 deer per square mile estimated by Houston (1982). Deer within the study area occur in ratios of 41 males to 100 females and 56 fawns to 100 females.

Mule deer mortality was attributed to winter malnutrition, predation, hunting, and poaching. The major predators were coyotes and mountain lions. The study area is within Montana Department of Fish, Wildlife and Parks' Hunting District 313. The 1981 regular season harvest from this district was 380 mule deer.

Bighorn Sheep

Houston (1982) described a bighorn sheep range that generally followed a wide corridor along the Yellowstone River between Dome Mountain and the Lamar River. The study area included a very small portion of this range.

Bighorn lived year-round in rugged habitats along the Black Canyon of the Yellowstone (10 observations). They were also observed on Deckard Flats (3 observations), Buffalo Mountain (1 observation), Crevice Mountain (1 observation), and just north of Gardiner (1 observation). Bands observed on Deckard Flats ranged from 9 to 22 individuals. The minimum winter population in the study area was 21 sheep. Bighorn mostly used big sage/grassland and cliff habitat types. Although lambing grounds were not located, lambs have been observed in the study area. Mortality of bighorn was due to hunting, predation, and disease.

Moose

Moose were sighted on 20 occasions in the study area (26 individuals). They inhabited major drainages and forested areas. There were no apparent seasonal changes in moose density nor were any distinct elevational movements indicated. Six cows with calves were sighted. These calves were probably born somewhere in the study area. Moose can be legally hunted in the study area; some poaching may also occur.

Bison

Deckard Flats and areas along the Yellowstone are considered historic bison winter range (Mary Meagher, National Park Service, in Westech, pers. comm., 1984). Current bison use of the study area, although increasing, is sporadic. During baseline studies, only four bison were seen. Twelve to fifteen bison inhabited the Eagle Creek area during spring, 1984 (Ken Czarnowski, Resource Management Specialist, National Park Service, pers. comm., July 25, 1985).

Black Bear

A total of 13 black bears were observed on 7 occasions. Their tracks or hair were found at 7 locations. Black bears apparently den along lower Bear Creek and upper Pine Creek. Their life requirements are satisfied by a variety of habitat types. The presence of females with cubs indicates that birth occurs in the study area. In 1981, hunters killed one bear along upper Bear Creek and another along upper Eagle Creek. (Grizzly bears are discussed in Chapter II--Threatened and Endangered Species.)

Mountain Lion

No mountain lions were seen in the study area. Tracks, however, were noted in the Black Canyon of the Yellowstone, along lower Bear Creek, and on Deckard Flats. An area resident reported an incident of lion predation on a bighorn.

Small- and Medium-sized Mammals

Nine species of small mammals were trapped: deer mouse, common shrew, red-backed vole, meadow vole, western jumping mouse, yellow pine chipmunk, red squirrel, Columbian ground squirrel, and northern flying squirrel. Deer mice were the most frequently trapped species and occurred in all habitat types. Their maximum home range was 1.1 acre. Shrews inhabited the clear-cut and creek bottom types while red-backed voles lived in forested areas. As expected, the meadow vole was captured only in moist habitats. The other five species were captured infrequently.

Mountain cottontails, yellow-bellied marmots, and porcupines were commonly observed herbivores. White-tailed jackrabbits and snowshoe hares were less common. Weasels, martens, and coyotes were frequently observed predators. Coyote density on the study area fell during winter. This decline was caused by trapping or emigration. Coyote dens exist on Mineral Hill and on lower Eagle Creek. Other predators inhabiting the study area were red foxes and bobcats.

Raptors (Birds of Prey)

Sixteen raptorial species were observed in addition to the bald eagle and peregrine falcon (see Chapter II--Threatened and Endangered Species). American kestrels were the most common nesting raptors. Three red-tailed hawk nesting territories were identified, and a suspected nest was located along Bear Creek. Two nesting territories of great horned owls were discovered. Other species possibly nesting in the study area were: goshawk, Cooper's hawk, sharp-shinned hawk, prairie falcon, merlin, and long-eared owl. Golden eagles hunted over open habitats along Eagle Creek and the Yellowstone River. Swainson's hawks, ferruginous hawks, rough-legged hawks, northern harriers, ospreys, and short-eared owls were all occasionally observed in the study area.

Songbirds

Forty-three songbird species were seen from May to July along survey transects (appendix 2). The mountain chickadee, the dark-eyed junco, the chipping sparrow, and the robin were among the most common species.

Creek bottom and Douglas-fir/big sage habitat types supported the highest number of species (figure II-15). The greatest number of species inhabited the study area in June, while the least number was present in December. Several species were year-round residents.

Gamebirds and Waterfowl

Ruffed grouse used creek bottom habitat types along lower Eagle Creek and lower Bear Creek. Blue grouse were observed at higher elevations in a variety of habitat types. They were present in all seasons. Waterfowl recorded in the study area were mallards, gadwalls, pintails, green-winged teal, blue-winged teal, and common mergansers.

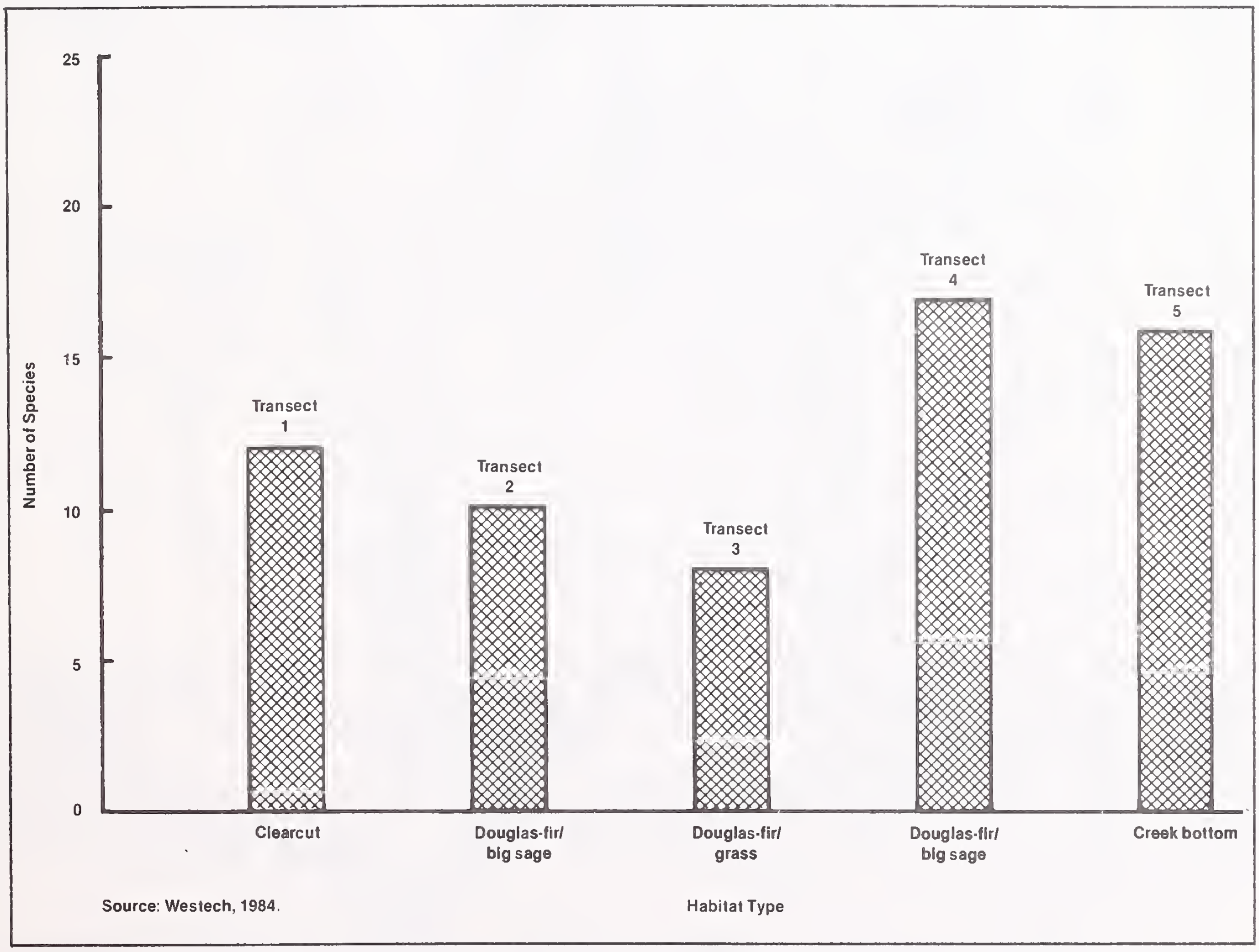


Figure II-15: Creek bottom and Douglas-fir/big sage habitat types support the highest number of species of songbirds.

Reptiles and Amphibians

All three reptile species seen in the study area lived below an elevation of 7,200 feet. Racers and prairie rattlesnakes inhabited grassland and big sage/grass habitats. Garter snakes were associated with riparian habitats. The lone amphibian species, the spotted frog, was common near water at upper elevations.

THREATENED AND ENDANGERED SPECIES

The assessment area for threatened and endangered species makes up the southwestern portion of the Hellroaring/Bear (Creek) Bear Management Unit (see figure II-16).

At the request of the U.S. Forest Service, the U.S. Fish and Wildlife Service provided a list of threatened and endangered species that could occur in the assessment area (U.S. Fish and Wildlife Service, pers. comm., October 19, 1984). The list was comprised of one threatened and three endangered species (table II-16). There are no federally listed threatened and endangered plants (U.S. Fish and Wildlife Service, 1984) within the assessment area.

Table II-16. Threatened and endangered species that could occur in the assessment area

Species[1]	Federal classification	Status in assessment area
Grizzly bear	Threatened	Year-long resident
Bald eagle	Endangered	Winter and spring resident
Peregrine falcon	Endangered	Spring and fall migrant
Gray wolf	Endangered	Unknown

[1] See appendix 3 for scientific names.

Grizzly Bears

Radio telemetry and direct observations are used to determine grizzly bear distribution, population changes, and habitat use. Knight and Eberhardt (1985) included the Jardine area in a high-density grizzly bear zone of the Yellowstone ecosystem (figure II-17). The large home ranges of grizzlies suggest that the proposed permit area may sometimes be used by grizzlies from distant areas. The U.S. Fish and Wildlife Service (1982) lists average home ranges for females at 105 square miles and states that some individuals roam over 1,000 square miles.

Before their relocation in the early 1980s, three radio-collared females inhabited the assessment area. Grizzlies or grizzly sign were observed 13 times near Jardine in 1981 and 1982 (Westech, 1984). From 1983 to 1984, 24

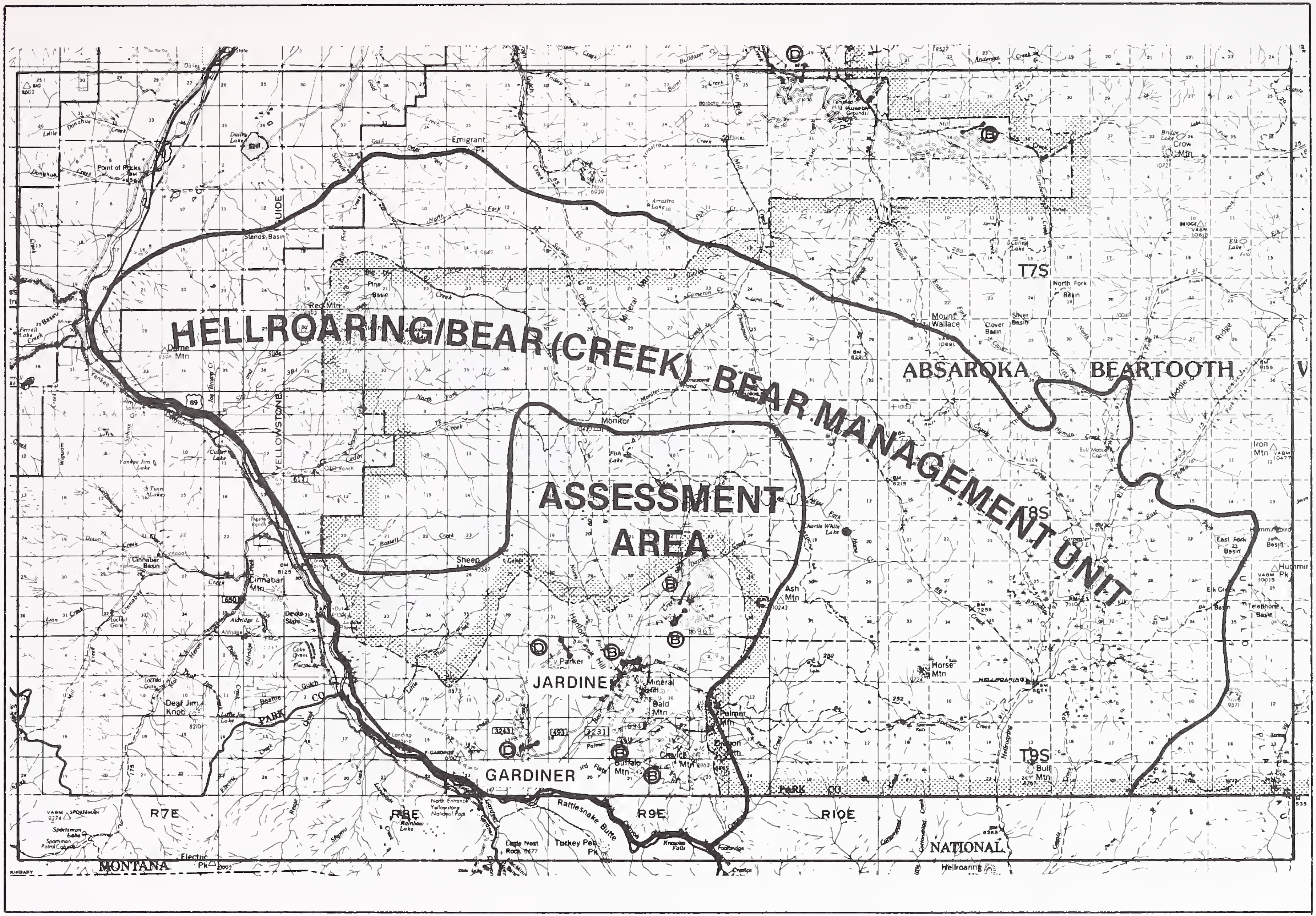


Figure II-16: The proposed project would take place within the "threatened and endangered species" assessment area shown here. This assessment area is part of the Hellroaring/Bear (Creek) Bear Management Unit. Source: U.S.D.A. Forest Service, 1985a.

grizzly bear observations were made in the area east of Gardiner (National Park Service, 1985). During the late summer and fall of 1984, three grizzlies were observed in the assessment area, according to the Interagency Grizzly Bear Study Team (IGBST, 1984). Figure II-18 shows observations made from 1975-1984.

From 1981 to 1984, a total of 121 bear management actions were taken by government agencies (National Park Service, 1985). These actions, some occurring in the assessment area, included the destruction of some bears and the relocation of others from the Yellowstone area (table II-17). Grizzlies are also killed by poachers and die from natural causes. Females apparently have particularly high mortality rates (IGBST, 1979-1982). In light of such mortality, the IGBST (1982) has expressed concern about the grizzly population's continued existence in the Yellowstone area.

Craighead and Craighead (1977) reported six grizzly mortalities in the assessment area from 1959 through 1974. Between 1975 and 1980, one grizzly was killed in the assessment area (Knight et al., 1975-1982). Because the assessment area constitutes less than 1 percent of occupied grizzly bear habitat, these incidents represent a relatively high number of mortalities.

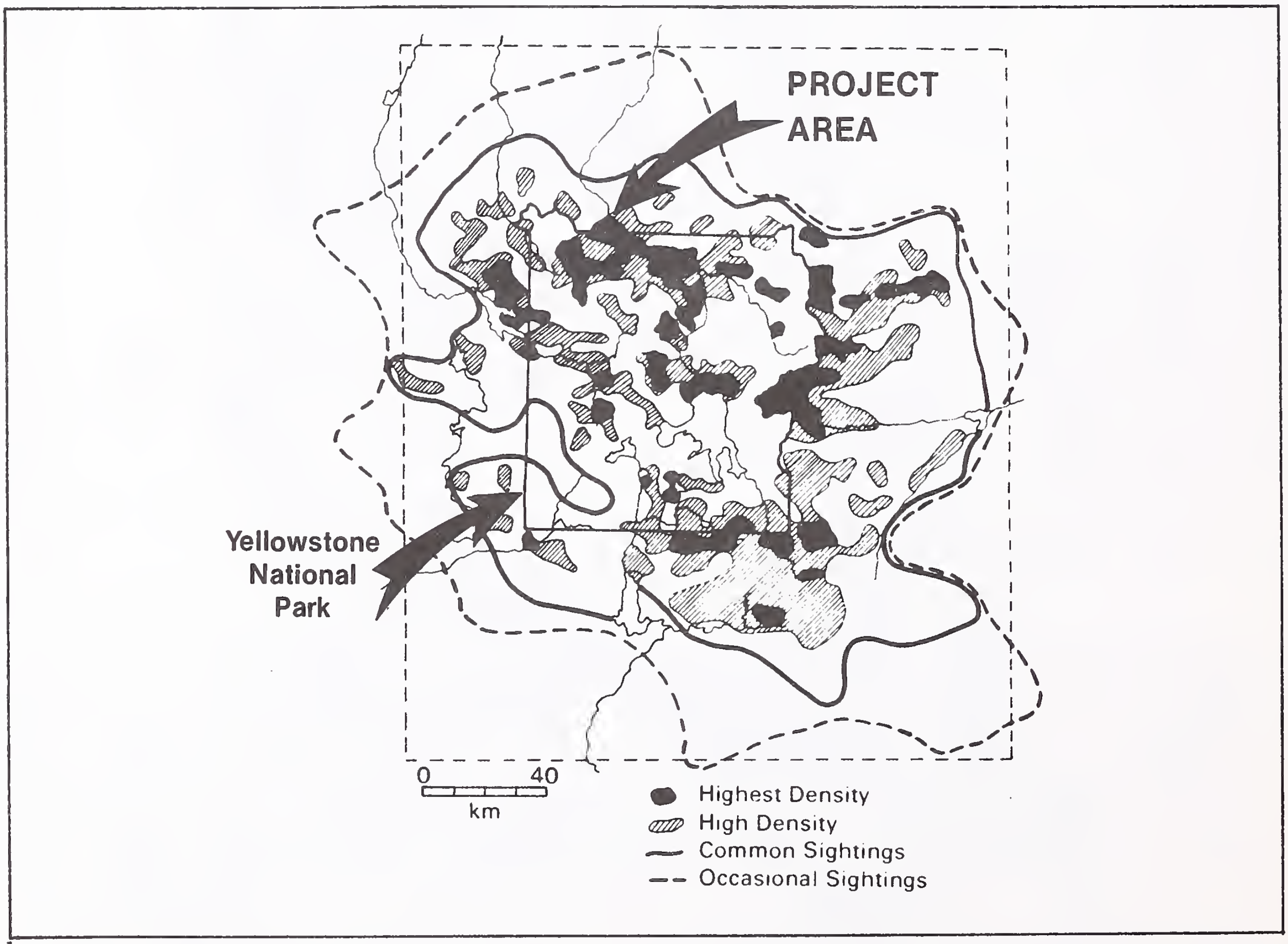


Figure II-17: Knight and Eberhardt (1985) included the Jardine area in a high-density grizzly bear zone of the Yellowstone ecosystem.

Table II-17. Bear Management Actions in the Yellowstone Area, 1981-1984

Year	Total actions in Yellowstone area[1]	Removal from Yellowstone area		Removal from assessment area	
		Mortality	Relocation	Mortality	Relocation
1981	49	17	1	3	2
1982	25	3	3	0	2
1983	19	4	3	2	3
1984	28	7	2	0	1
Totals	121	31	10	5	8

Source: U.S. Department of the Interior, National Park Service, 1985.

[1] Some actions involved relocating a bear to another part of the Yellowstone area.

Bear management actions are taken when conflicts occur between grizzlies and humans. Conflicts can arise when grizzlies become accustomed to using foods brought in by people. In 1983, conflicts in the assessment area were resolved by trapping and relocating three female grizzlies. Conflicts and subsequent management actions are not unique to the assessment area; actions have also been taken near the towns of West Yellowstone and Cooke City and in some developed areas in Yellowstone National Park.

Climate influences the number of conflicts between grizzlies and humans. Certain climatic conditions, such as mild winters, summer frosts, and little summer precipitation, reduce the availability of natural grizzly foods. The bears expand their foraging range, sometimes including residential and recreational areas.

Grizzly bears use a variety of habitat types to satisfy their life requirements (table II-18). Interagency Grizzly Bear Study Team methodology has been used to classify most habitats in the Yellowstone area. The assessment area encompasses suitable year-round habitats (figure II-19). Five seasonal habitats are described below:

Spring (April 1-June 15). Elk carrion and succulent plants are the primary grizzly foods during the post-denning period. After emerging from their dens, grizzlies search for these foods in Douglas-fir forests and big sage/grasslands. Carrion and plant foods are most abundant in low-elevation areas with southerly aspects.

Summer (June 16-August 15). Grizzlies often forage in mountain grasslands. These high-elevation grasslands occur in the assessment area and contain preferred plant foods (table II-18). Summer frosts or low precipitation, however, can severely reduce the quantity and quality of these plants.

Early Fall (August 16-September 30). Whitebark pine nuts in the subalpine fir/whitebark pine/grouse whortleberry and the whitebark pine/grouse whortleberry habitat types attract grizzlies. Grizzlies also seek succulent plants in meadows and drainages.

Table II-18: Grizzly bear habitat in the assessment area

Season	Habitat Factor	Climax Habitat Type[1]
Spring	Cover	Douglas-fir types
		Engelmann spruce types
	Forage	Big sagebrush/Idaho fescue
		Big sagebrush/bluebunch wheatgrass
		Idaho fescue/bluebunch wheatgrass
		Bluebunch wheatgrass/Idaho fescue
		Douglas-fir types
Summer	Cover	Engelmann spruce types
		Subalpine fir types
	Forage	Subalpine fir/huckleberry
		Subalpine fir/twinflower/grouse whortleberry
		Idaho fescue/tufted hairgrass
		Tufted hairgrass/sedge
		Idaho fescue/threadleaf sedge
Early Fall	Cover	Engelmann spruce types
		Subalpine fir types
	Forage	Subalpine fir/whitebark pine/grouse whortleberry
		Whitebark pine/grouse whortleberry
		Idaho fescue/tufted hairgrass
		Tufted hairgrass/sedge
		Idaho fescue/threadleaf sedge
Late Fall	Cover	Subalpine fir types
	Forage	Subalpine fir/whitebark pine/ grouse whortleberry
		Subalpine fir types
Winter	Cover	Subalpine fir/grouse whortleberry
		Subalpine fir/whitebark pine/ grouse whortleberry
		Whitebark pine/grouse whortleberry

Source: Jerry T. Light, USDA Forest Service, Gallatin National Forest, pers. comm., June, 1985.

[1] See appendix 8 for scientific names. Grassland and shrub/grassland types follow Mueggler and Stewart (1980) while forest types follow Pfister et al. (1977).

<u>Late Fall</u> (October 1-November 30). Before entering their dens, grizzlies obtain whitebark pine nuts by raiding squirrel caches. Rut-weakened elk and moose, inhabiting forested areas, provide higher-quality food.

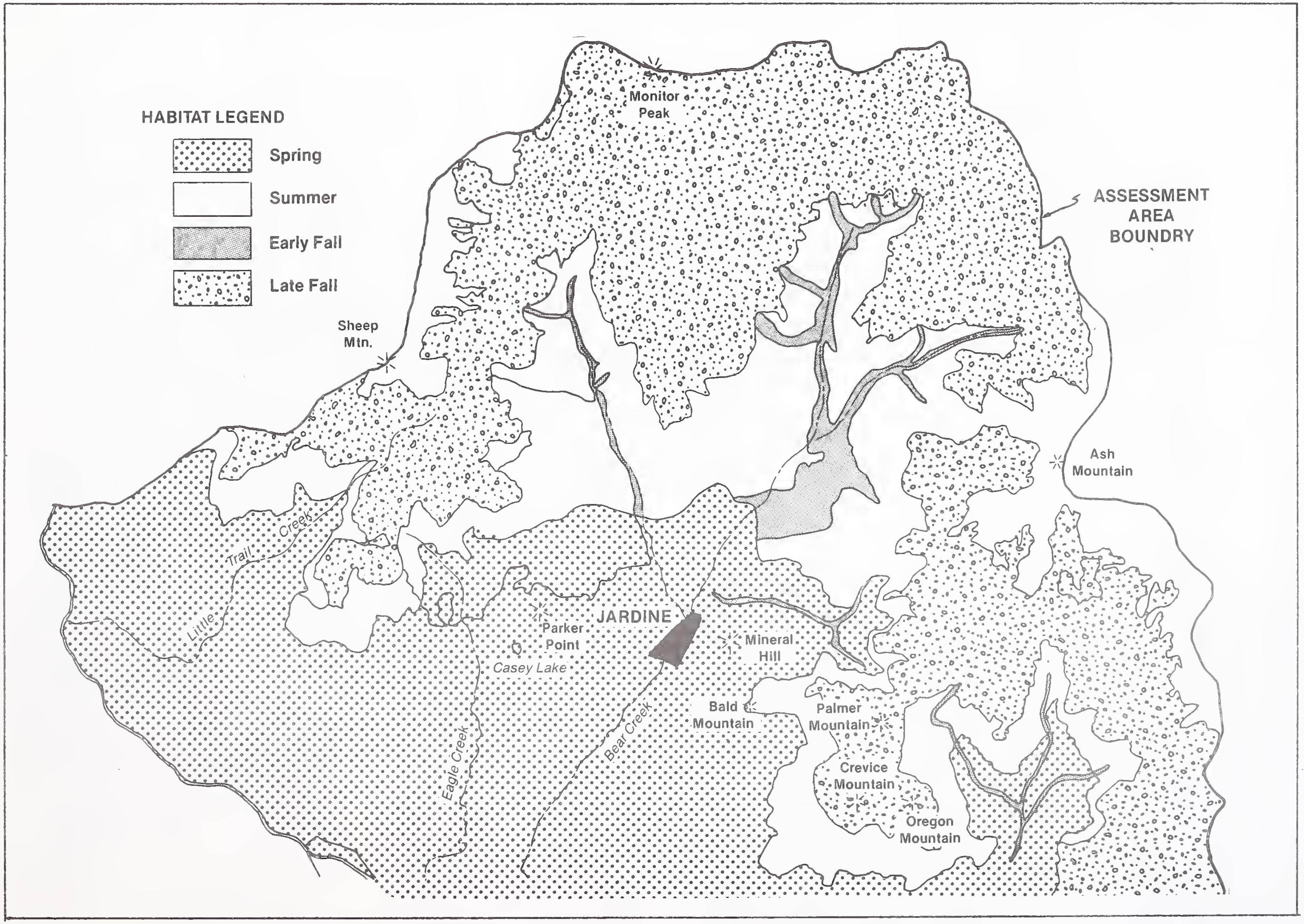


Figure II-19: Grizzly bear habitat use changes with the season. The assessment area includes suitable year-round habitats, detailed here by season.

Winter (December 1-April 30). Grizzlies spend most of the winter in dens. The best denning habitat in the Yellowstone area is usually above 8,100 feet, on steep slopes (30°-60°) and in the subalpine fir/grouse whortleberry, subalpine fir/whitebark pine/grouse whortleberry, and whitebark pine/grouse whortleberry habitat types (U.S. Forest Service, 1985).

Bald Eagle

From November through March, bald eagles are often sighted along the Yellowstone River. Their primary foods are fish and elk carrion. Westech (1984) reported 28 observations (49 individuals) of bald eagles in the assessment area during the winter of 1981-82 (figure II-20). Eagles tend to roost in groups; 11 roosting birds were sighted in a tree along lower Bear Creek. J.T. Light (U.S. Forest Service, pers. comm., July 8, 1985) also reported eagles roosting on a ridge north of Phelps Creek.

Two nests along Bear Creek, about one mile below Jardine, resemble bald eagle nests; however, eagle use of these nests after 1979 is not documented. One nest is deteriorating and the other has been used by red-tailed hawks. Swenson (1975) reported no bald eagle nesting territories in the assessment area.

Peregrine Falcon

Only one peregrine falcon has been recorded in the assessment area. Westech (1984) reported a peregrine flying over a big sagebrush/grassland on March 19, 1982. No nests have been found; however, there are some suitable habitat and nest sites in the assessment area. Wetlands, important hunting habitat to these birds, are found along the Yellowstone River and south of Blanding Guard Station. Cliffs provide suitable nest sites along the Yellowstone River and at the mouth of Bear Creek (Tom Puchlerz, U.S. Forest Service, pers. comm., July 10, 1985). Other suitable nest sites are 3 to 7 miles outside the assessment area.

Government agencies are currently introducing peregrine falcons in the Yellowstone area. More successful reintroductions could increase the importance of habitats in the assessment area.

Gray Wolf

Although the existence of gray wolves in the assessment has yet to be disproven, it is unlikely that they are residents. Wolf packs were probably eliminated from Yellowstone National Park in the 1920s (Weaver, 1978). Scattered individuals may roam the park today, but their presence is not well documented. If wolf populations recover, elk would supply an ample prey base.

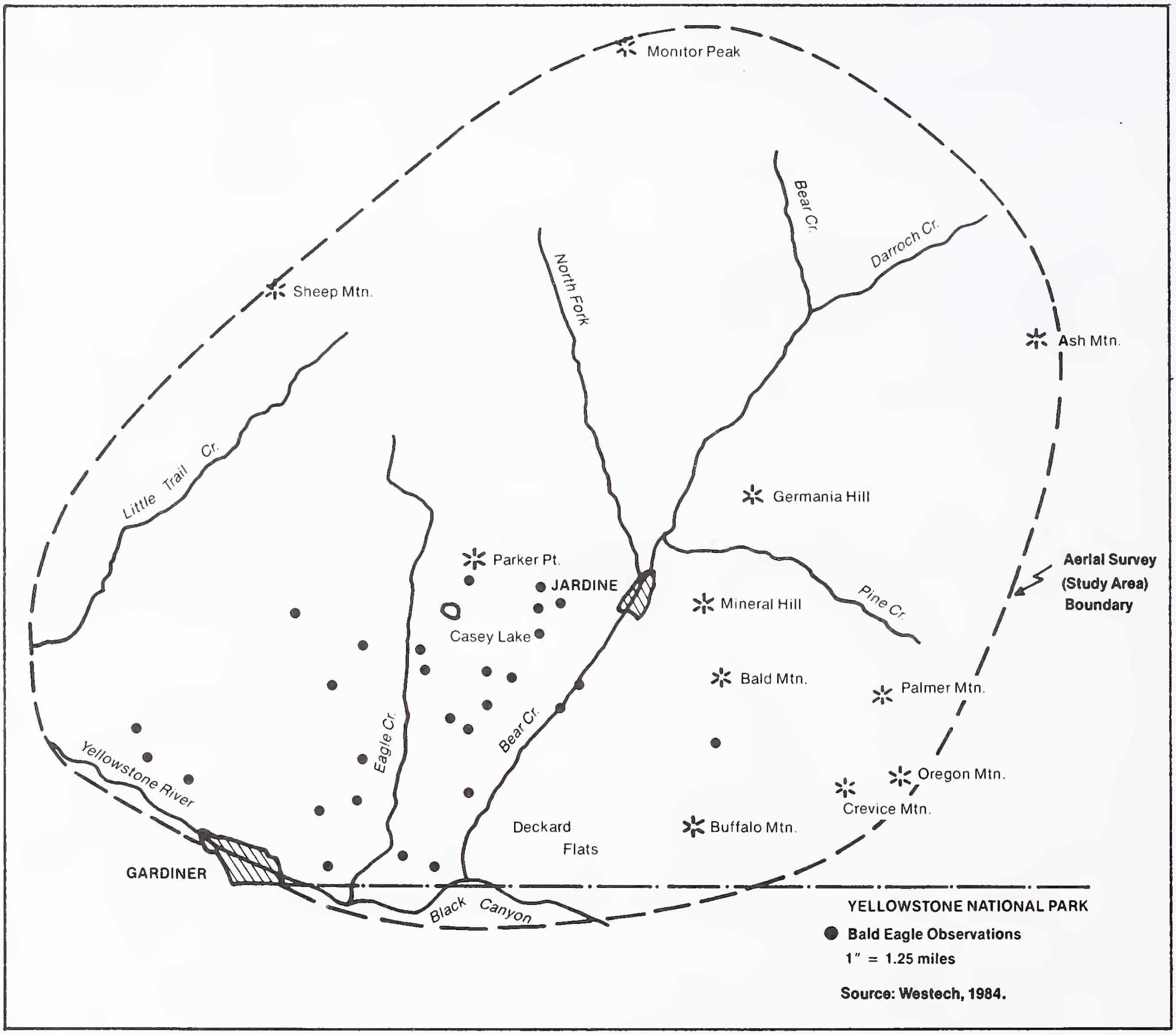


Figure II-20: Westech (1984) reported 28 observations of 49 bald eagles in the assessment area during the winter of 1981-82.

CLIMATE

Climate in the Jardine project area is characterized by long, cold winters and short, cool summers. Wind speeds are usually less than seven miles per hour; wind direction follows the orientation of the valley generally from the northeast or southwest.

Temperature

During the period August 6, 1981 through September 30, 1982, the highest temperature recorded at Jardine was 85°F in July and August; the coldest was -22°F in February. Monthly averages ranged from a high of 57°F in August to a low of 14°F in January. Figure II-21 presents monthly average maximum, average minimum, and average temperatures for the Jardine area during the study period.

Winds

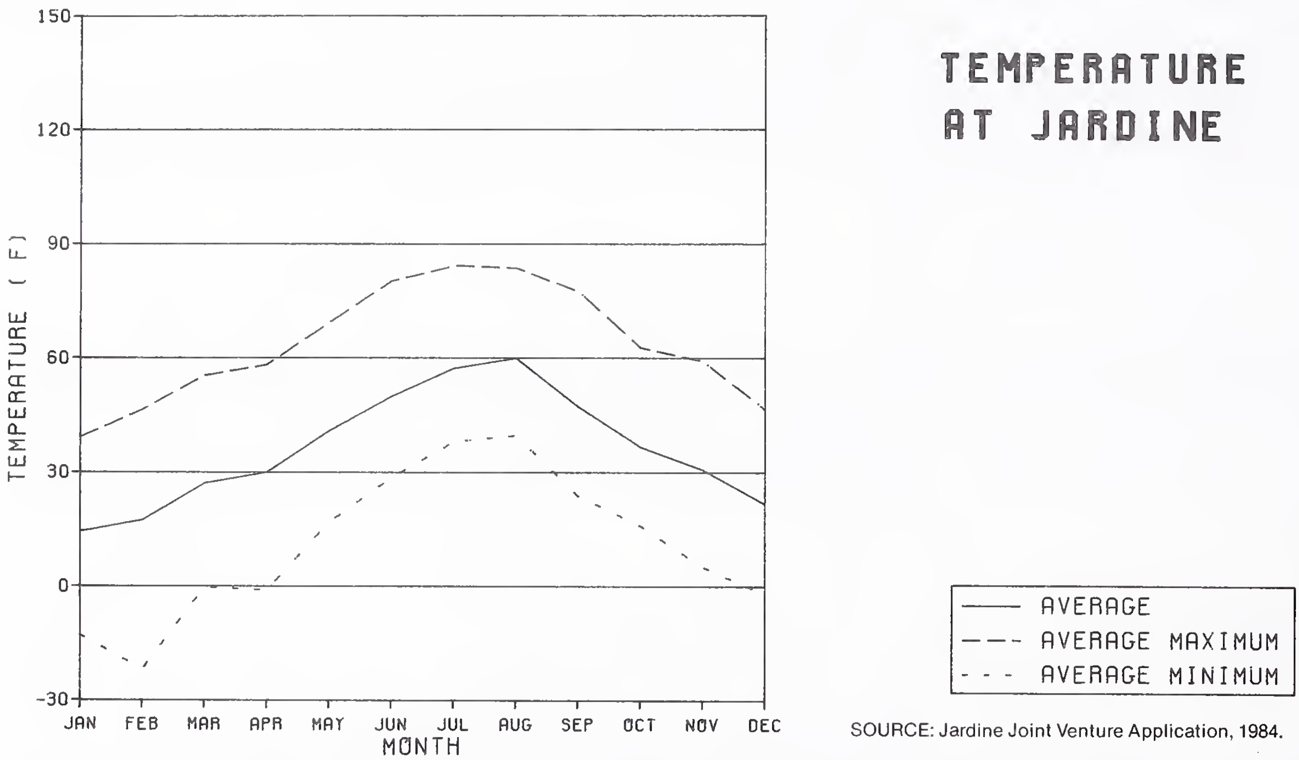
For the year of baseline study, 37 percent of the winds were down-valley (from the northeast and east-northeast) while 27 percent of the winds were up-valley (from the southwest and south-southwest). Only during the July-September quarter did this pattern change. The predominant flows were from the southeast, south-southeast, or northwest and north-northwest (figure II-22).

Wind speeds were low. No average hourly wind speed greater than 13.5 miles per hour (mph) was recorded. However, calm periods were essentially nonexistent. About 62 percent of the hourly average wind speeds were less than 4.5 mph, 88 percent were less than 6.7 mph. However, local residents say high winds occur frequently.

Precipitation and Evaporation

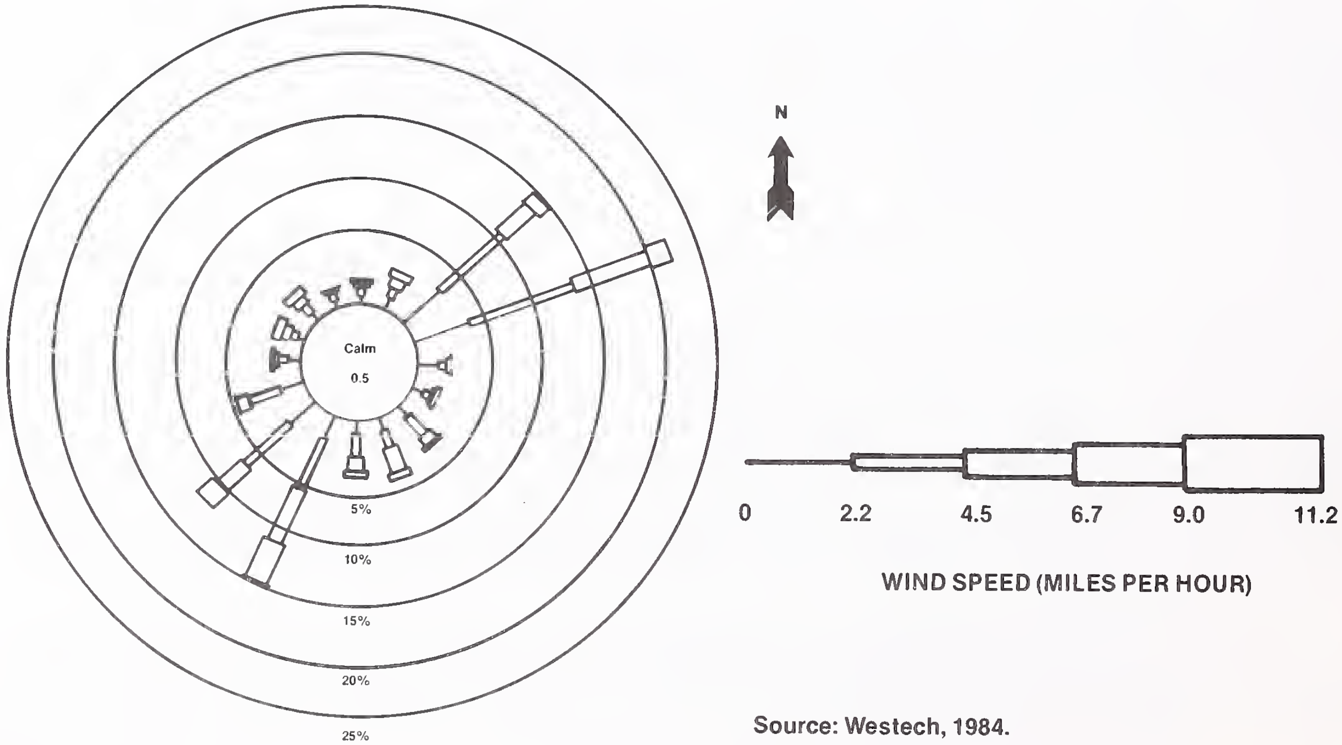
Precipitation was also measured during the study period August 1981 through September 1982 (project application, 1984). However, the information presented here is based on 20 years of data collection by the National Weather Service (NOAA, 1952-1971). Annual average precipitation is about 18 inches, ranging from 12.0 inches to 35.4 inches. June is the wettest month with 2.6 inches of precipitation, and March the driest with 1.0 inches (figure II-23). The frequency of precipitation events and probable maximum precipitation are shown in table II-19.

Average annual evaporation (open water) is about 27 inches. Virtually all evaporation occurs from April through October, ranging from 2 inches in October to 5.8 inches in July.



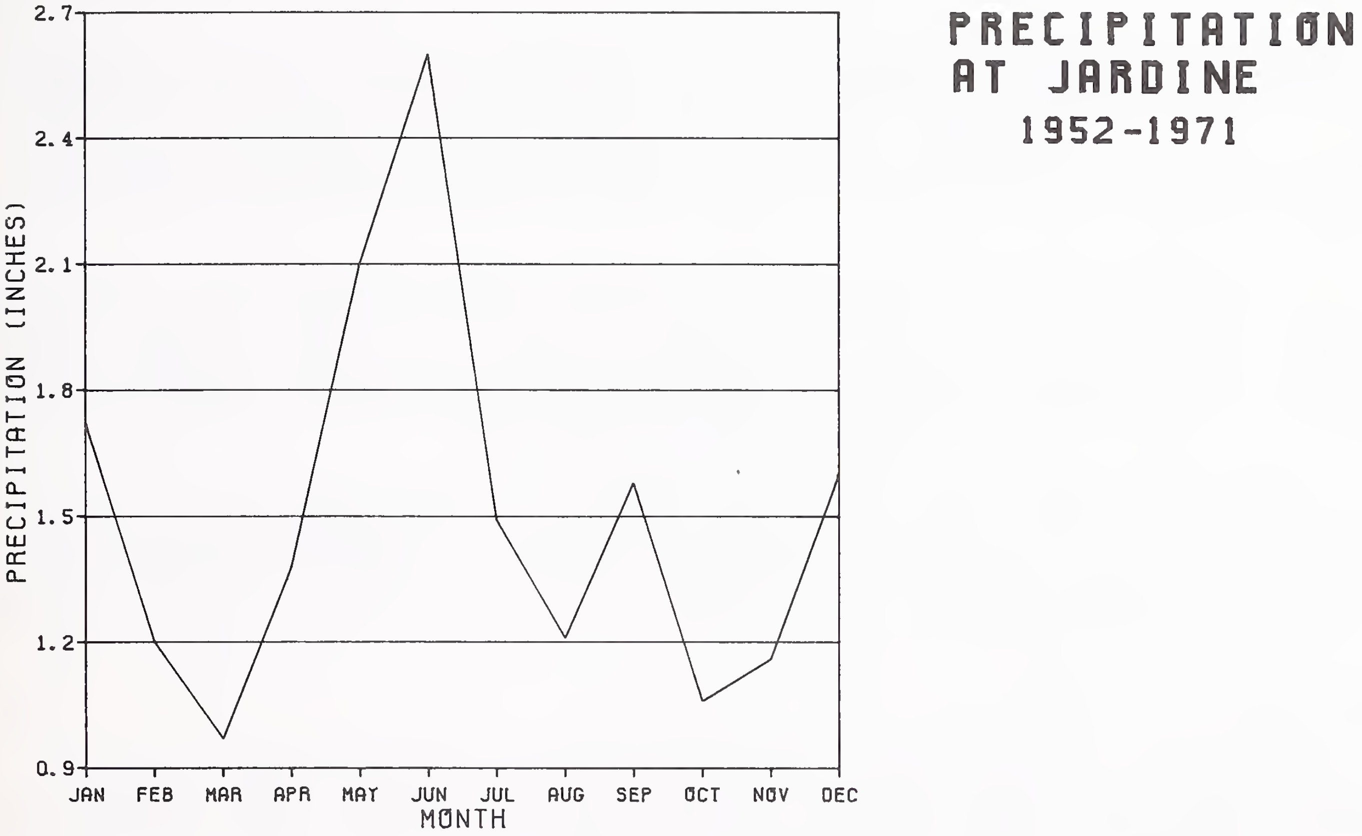
SOURCE: Jardine Joint Venture Application, 1984.

Figure II-21: The average temperature at Jardine was about 36°F during the period October 1, 1981 through September 30, 1982. August was the warmest month and January the coldest.



Source: Westech, 1984.

Figure II-22: Wind speeds measured at the mine site were generally below seven miles per hour. Winds blew from the northeast and southwest most of the time, following the Bear Creek drainage.



SOURCE: National Oceanic and Atmospheric Administration, 1952-1971.

Figure II-23: Average annual precipitation at Jardine is less than 18 inches. Seasonally, most of the precipitation occurs as rain during the spring. June is the wettest month, and March the driest.

Table II-19: Frequency and Probable Maximum of Precipitation

	Recurrence Intervals (Years)					
	2	5	10	25	50	100
6-Hour Event	0.7	1.0	1.2	1.2	1.6	1.8
24-Hour Event	1.0	1.4	1.8	2.2	2.6	2.8

Probable Maximum Precipitation (inches)	
Frequency	Maximum Precipitation
1 Hour	5
6 Hours	9
24 Hours	19
72 Hours	26

Source: Miller et al., 1984.

AIR QUALITY

The air quality measured at two monitoring stations near Jardine is good; however, during windy periods, dust plumes eminate from the existing tailings area. For the monitoring period of October 1981 through September 1982 the annual average total suspended particulate (TSP) concentration was about 20 micrograms per cubic meter (μg/m^3), well below the Montana Ambient Air Quality Standard (MAAQS) of 75 μg/m^3.

TSP concentrations were greatest during the warmer months (figure II-24), probably due to windblown dust from exposed areas--the existing tailings pond in particular--and roads. During the winter, these areas are frozen or snow covered. The highest 24-hour TSP concentration, 52 μg/m^3, was recorded in June. This level is well below the MAAQS of 200 μg/m^3.

Vehicle traffic, residential space heating, and mine exploration are the only potential gaseous pollutant sources in Jardine. Therefore, gaseous air pollutants, such as sulfur dioxide, ozone, nitrogen oxides, are present in only very low concentrations.

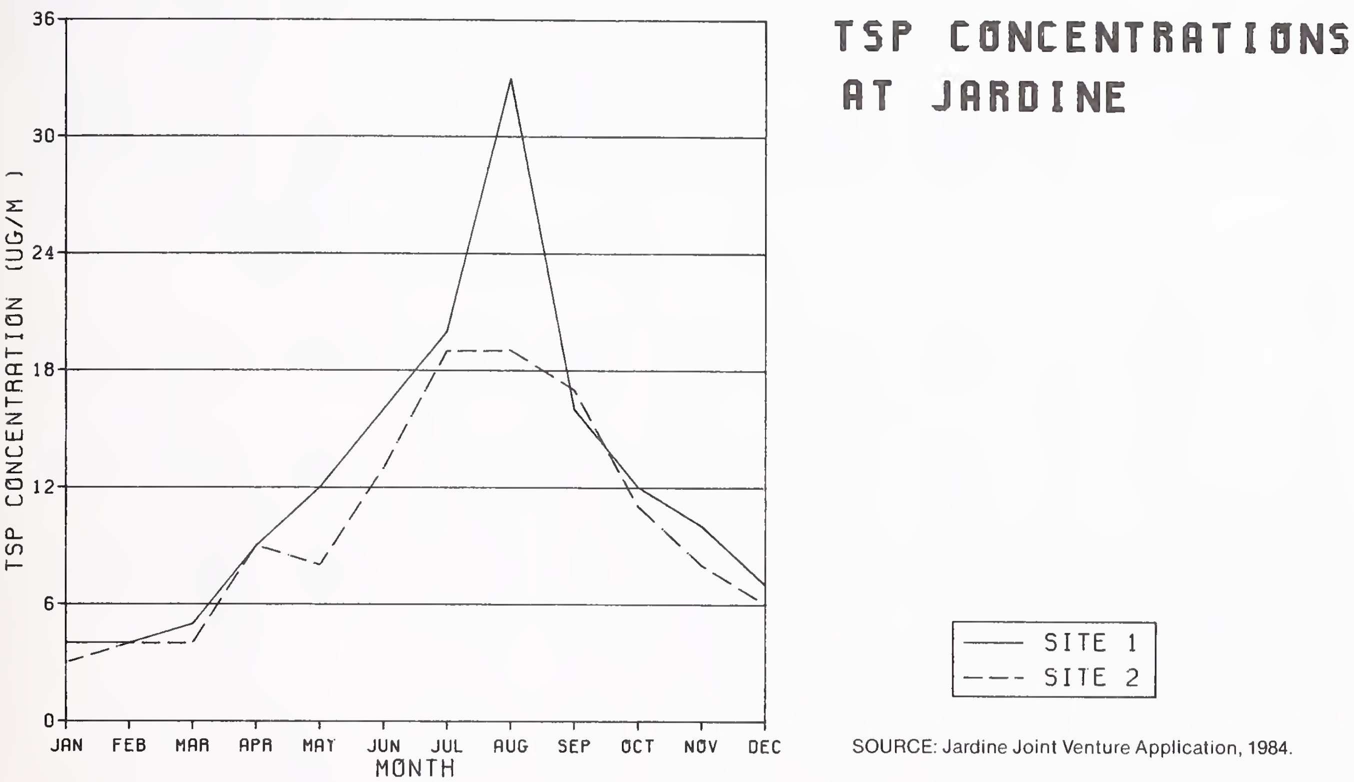
Visibility

A visibility study of the Jardine area was conducted at Mammoth, Wyoming (within Yellowstone Park) during 1981-82 (Tree and Hunt, 1982). Using a telephotometer and camera to measure visibility, the study concluded that visibility within the Jardine Basin is no different than visibility in the overall study region. The existing tailings pond is visible from the upper terraces at Mammoth.

INCOME

Total Park County personal income (not adjusted for inflation) grew from \$50,519,000 in 1973 to \$120,682,000 in 1983--almost 140 percent. However, inflation averaged 7.14 percent per year over that time period (Survey of Current Business, July 1975 and July 1984, implicit price deflator for personal consumption expenditures). Adjusting personal income figures for inflation shows that total Park County personal income increased 18 percent from 1973 to 1983, or 1.4 percent per year (see table II-20). Per capita income, in constant dollars, barely kept pace with inflation, increasing from \$4,104 in 1973 to \$4,216 in 1983, for an average annual increase of 0.24 percent above inflation.

Labor income, including wages and salaries, contributed the largest percentage to total county personal income (50.9 percent) in 1983. Dividends, rent, and interest--the second largest component--accounted for almost one-third of total personal income.



SOURCE: Jardine Joint Venture Application, 1984.

Figure II-24: Average total suspended particulate (TSP) concentrations were highest during the summer months, but well below all applicable standards throughout the year.

Transfer payments (social security, unemployment compensation, and social welfare payments) comprised about 18.0 percent of 1983 Park County personal income. Such payments have become a larger percentage of county personal income over the last five years. In 1979, transfer payments equaled 13.5 percent of total Park County personal income.

The transportation, communication, and public utilities sector accounted for 28.4 percent of Park County earned income (see table II-21). This sector has been the largest employment- and income-producing sector in Park County, producing above 30 percent of total income between 1978 and 1982. However, due to the reduction in force by Burlington Northern railroad, its total contribution to Park County income and employment has declined and will probably continue to decline.

The service and government sectors are the next largest income producers in Park County, providing 17.4 and 16.0 percent, of total earned income. Retail trade employment, accounting for 14.5 percent, is the only other sector contributing above 10 percent to total earned income in Park County.

Table II-20: Personal Income--Park County (thousands of 1980 dollars)

Item	1973	1977	1978	1979	1980	1981	1982	1983
Total personal income[1]	$85,715	$92,152	$101,143	$104,946	$102,703	$104,825	$102,603	$101,133
Nonfarm personal income[2]	75,770	90,641	96,263	99,857	98,409	101,727	101,049	100,250
Farm personal income	9,945	1,511	4,880	5,089	4,294	3,098	1,554	883
Derivation of personal income								
Total earnings by type of work[3]	60,466	62,131	68,781	69,896	64,827	63,559	57,413	55,919
Less: personal contribution for social insurance	3,458	4,575	3,903	4,179	4,019	4,604	4,565	4,542
Plus: residence adjustment	1,120	1,371	1,435	1,439	1,854	1,880	2,069	1,811
Equals: net earnings	58,128	58,927	66,313	67,155	62,662	60,835	54,917	53,188
Plus: dividends, interest, and rent[4]	16,563	19,744	21,286	23,652	24,525	27,676	30,036	29,787
Plus: transfer payments	11,023	13,481	13,544	14,138	15,516	16,314	17,651	18,158
Population: thousands	11.7	12.4	12.8	13.0	13.0	13.5	13.4	13.4
Per capita personal income (not in thousands of dollars)	7,347	7,427	7,914	8,094	7,914	7,782	7,673	7,546
Components of earnings								
Wages and salaries	43,859	50,665	53,747	56,067	53,356	51,568	49,302	47,224
Other labor income	2,572	4,012	4,246	4,148	3,936	3,764	4,209	4,297
Proprietors' income[5]	14,035	7,465	10,788	9,680	7,535	8,228	3,902	4,398
Farm	7,484	545	2,639	2,487	1,742	790	966	-1,532
Nonfarm	6,551	8,009	8,149	7,193	5,793	7,438	4,868	5,930

Source: U.S. Department of Commerce, Bureau of Economic Analysis, April 1985, Table 5.00.
*Add may not add due to rounding.

[1] Income figures are adjusted for inflation using the deflator for personal consumption expenditures as cited in the Survey of Current Business, July issues 1975, 1977, 1979, 1982, and 1984.

[2] Nonfarm personal income equals total personal income less farm earnings (labor and proprietors' income.

[3] Earnings consist of wage and salary disbursements, other labor income, and proprietors' income.

[4] Dividends, interest, and rent include a capital consumption adjustment for retal income.

[5] Proprietors' income includes inventory valuation and capital consumption adjustments for nonfarm proprietors.

Table II-21: Earnings by Industry--Park County[1] (thousands of 1980 dollars)

Earnings by industry	1973	1977	1978	1979	1980	1981	1982	1983
Total earned income	$60,466	$62,131	$68,781	$69,896	$64,827	$63,559	$57,413	$56,077
Farm	9,961	1,511	4,880	5,089	4,294	3,098	1,555	886
Nonfarm	50,505	60,620	63,901	64,807	60,533	60,462	55,858	55,191
Private	43,488	52,908	55,992	56,778	52,446	52,073	47,496	46,233
Agricultural services, forestry, fisheries, and other[2]	312	622	556	573	584	316	266	(D)
Mining	(L)	(L)	(L)	178	236	207	(L)	(D)
Construction	3,119	4,720	5,077	4,250	3,150	4,021	4,872	3,562
Manufacturing	4,925	6,891	7,386	7,205	5,353	5,043	4,311	4,687
Non-durable goods	1,067	1,552	1,672	1,944	2,016	1,240	1,209	1,176
Durable goods	3,858	5,339	5,713	5,261	3,337	3,804	3,102	3,511
Transportation, communication and public utilities	16,868	20,159	21,539	23,247	22,069	20,724	18,069	15,932
Wholesale trade	853	837	844	859	784	1,266	1,566	1,394
Retail trade	7,720	8,245	8,256	8,097	7,617	8,829	8,119	8,140
Finance, insurance, and real estate	2,287	3,101	3,461	3,485	3,217	2,523	2,234	2,328
Services	7,336	8,291	8,848	8,883	9,436	9,392	8,451	9,736
Government	7,017	7,711	7,909	8,029	8,087	8,140	8,363	8,958
Federal, civilian	1,298	1,232	1,289	1,300	1,345	1,425	1,291	1,325
Federal, military	260	213	220	218	223	200	208	266
State and local	5,460	6,266	6,400	6,511	6,519	6,516	6,864	7,367

Source: U.S. Department of Commerce, Bureau of Economic Analysis, April 1985, Table 5.00.

[1]Earnings have been deflated to 1980 dollars using the implicit price deflator for personal consumption expenditures, Survey of Current Business, July issues, 1975, 1977, 1979, 1982, and 1984.

[2]Other includes wages and salaries of U.S. citizens working for international organizations in the United States.

(L) means less than $50,000 and (D) indicates that data is not shown to avoid disclosure of confidential information. Numbers may not total correctly due to rounding.

Park County farm income was affected by the recession more than other sectors. Farm income (in constant 1980 dollars) peaked in 1973 at $10.0 million and dropped 77.2 percent to less than one million in 1983 (see table II-21). The agricultural sector declined statewide, although not as much as in Park County. Between 1981 and 1983, statewide agricultural income declined 33.6 percent to $214.2 million in 1983.

Personal Income

Personal income is projected to increase 112 percent from 1980 to 2010 (see table II-22). This forecast is based on several assumptions. Employment forecasts were generated by WEDM, a computer model developed by Mountain International, Inc., a consultant to the applicant. Employment forecasts (by sector) were then multiplied by projected income per worker (Mountain International, 1984, vol. 1, pp. 275-278).

Agricultural labor income was determined by applying statewide rates for agriculture as projected by the Bureau of Economic Analysis (BEA) to the 10-year average for agricultural labor income in Park County. The 10-year average corrected for fluctuations in agricultural income.

Non-agricultural income was estimated by multiplying Park County employment projected by WEDM by the statewide growth rate reported by BEA. Transfer payments and property income were projected by multiplying the 1980 Park County level of such income by the statewide rates developed by BEA. Social security contributions were estimated based on the 1980-level in Park County.

Agricultural labor income is growing from $2.9 million in 1980 to $9.3 million in 2010. Nonagricultural income shows gains also--more than doubling over the forecast period. Property income and transfer payments show the smallest increase of all the income component forecasts.

Per capita (per person) income shows an 81 percent increase from 1980 to 2010, rising from $7,871 to $14,284. Such an increase represents an annual average increase of 2 percent. The forecast is in constant 1980 dollars and does not include inflation.

EMPLOYMENT

The effects of the 1980-1982 recession are still present in Park County. The total number of jobs is still below the pre-recession peak employment in 1979. Layoffs by the Burlington Northern railroad (BN) and declines in the agriculture sector contributed to the recent decrease in Park County employment. Total employment in Park County increased from 1970 to 1982 (see table II-23). However, employment peaked in 1979 at 5,827 jobs and declined almost 5 percent between 1979 and 1982. Total employment in Montana followed a similar course--increasing from 1970 to 1983, with a peak of 373,238 jobs in 1979 (Bureau of Economic Analysis, 1984, table 25).

Employment declines in Park County and Montana were caused by the 1980-1982 recession and the loss of high-paying jobs in basic industries. Basic industries are those that sell products and materials to businesses or people from outside the state (in the case of Montana) and outside the county (in the case of Park County). Montana lost over 7,000 basic industry jobs, in part due to the shutdown of the Milwaukee Railroad and the closure of all Anaconda Company mining and smelting operations (Economics Montana, March 1985, p. 1). Park County basic industry employment declined due to layoffs by BN and transfer of Mountain Bell employees to Billings. BN employment was about 1,100 at one point during 1979, but declined to about 450 employees in 1983 (Mountain International, 1984a, p. 270).

Table II-22: Projections of Baseline Personal Income, Park County[1] 1980 to 2010 (in thousands of 1980 dollars)

	1980	1981	1982	1983	1984	1985	1990	1995	2000	2005	2010
Agriculture	$ 2,914	$ 4,922	$ 5,102	$ 5,296	$ 5,489	$ 5,687	$ 6,637	$ 7,274	$ 7,852	$ 8,541	$ 9,286
Nonagriculture	61,434	71,042	68,874	66,454	68,946	71,536	85,935	102,032	118,466	137,551	151,963
Property income and transfer payments	42,066	43,776	44,659	45,581	45,232	44,905	52,845	46,697	52,799	59,781	67,881
Social insurance contribution	-5,117	-6,070	-5,948	-5,797	-6,052	-6,309	-7,572	-8,777	-11,051	-12,462	-13,448
Total personal income	$101,297	$113,670	$112,687	$111,534	$113,615	$115,819	$137,845	$147,226	$168,102	$193,411	$215,682
Population	12,869	13,300	13,200	13,300	13,400	13,200	13,600	13,950	14,350	14,700	15,100
Per capita income	$ 7,871	$ 8,547	$ 8,547	$ 8,386	$ 8,479	$ 8,774	$ 10,136	$ 10,554	$ 11,714	$ 13,157	$ 14,284

Source: Mountain International, Inc., 1984, vol. 1, p. 277, income forecasts. Economic Consultants Northwest, sociology section, 1984, population forecasts.

[1] Yellowstone National Park is included.

Table II-23: Park County Employment by Type of Work[1]

Employment by type of work	1970	1976	1977	1978	1979	1980	1981	1982
Total employment by type of work	4,526	5,167	5,391	5,648	5,827	5,634	5,573	5,536
Wage and salary								
Farm	217	206	176	178	210	199	199	197
Nonfarm	3,234	3,944	4,108	4,314	4,423	4,186	4,109	4,048
Total wage and salary	3,451	4,150	4,284	4,492	4,633	4,385	4,308	4,245
Private employment								
Agricultural services, forestry, and fisheries	23	20	20	18	19	19	22	23
Mining	0	0	0	0	(L)	10	14	(L)
Construction	102	163	201	217	199	167	164	219
Manufacturing	264	483	456	473	474	380	333	293
Non-durable goods	113	114	129	134	166	167	97	85
Durable goods	151	369	327	339	308	213	236	208
Transportation and public utilities	749	778	883	918	945	928	880	797
Wholesale trade	20	34	38	44	43	41	41	46
Retail trade	648	860	778	825	830	782	828	812
Finance, insurance and real estate	178	185	199	242	237	237	203	179
Services	700	765	885	906	966	942	930	956
Total private employment	2,661	3,288	3,460	3,643	3,722	3,506	3,415	3,328
Government employment								
Federal	169	168	150	157	161	160	152	142
State and local	404	488	498	514	540	520	542	578
Total government employment	563	656	648	671	701	680	694	720
Number of proprietors								
Farm proprietors	399	346	349	346	346	346	346	346
Non-farm proprietors	653	671	758	810	848	903	919	945
Total proprietors	1,052	1,017	1,107	1,156	1,194	1,249	1,265	1,291

Source: U.S. Department of Commerce, Bureau of Economic Analysis, April 1984, and Census and Economic Information Center, 1983.

[1] Also known as "place of work." Employment estimates for 1976-1982 are based on 1972 Standard Industrial Codes. Estimates of 1970 employment are based on 1967 Standard Industrial Codes.
(L) This symbol indicates fewer than 10 jobs; however, the number is included in totals.

Park County manufacturing employment declined from its highest level of 483 jobs in 1976 to 293 in 1982. Closure of Birkeland Studs, Inc., a wood products manufacturer, contributed a loss of 150 to 200 basic industry jobs in the manufacturing sector (Mountain International, 1984a, p. 271).

About 53 basic industry jobs were lost in the agricultural sector of Park County from 1970 to 1982. The number of nonbasic (derivative) jobs that serve the agricultural sector also declined over that period (see table II-23).

Other sectors of employment--particularly those related to tourism--have been more stable. The service sector is the largest employer, providing about 17 percent of total Park County employment in 1982. Employment in this sector has remained fairly constant from 1978 to 1982 and has recovered more quickly from the recession than employment in other sectors. The 1982 level of employment in the service sector is only 10 jobs fewer than the pre-recession high in 1979 of 966 jobs (see table II-23).

Retail trade, the second largest employer in Park County, grew from 648 jobs in 1970 to a peak of 860 in 1976. During the recession, the number of jobs in the retail trade sector declined to 782 in 1980, about 12 percent below the 1979 level of 830. Retail trade employment stood at 812 jobs in 1982.

Neither the economy of Montana nor Park County has regained pre-recession peak levels of employment. Forecasts for the state predict that the Montana economy should improve to a level equal to its pre-recession peak by late 1985 (Economics Montana, March, 1985, p.1). The Park County economy should also improve, although more slowly than the state economy. County employment will continue to have the strongest recovery in the retail trade and service sectors (see table II-24). However, employment in the transportation and public utilities sector will not regain historic high levels due to recent layoffs by the Burlington Northern Railroad.

Park County Unemployment

Park County unemployment has ranged from a low of 5.3 percent annually to 10.8 percent over the period 1976 to 1984 (see table II-24). Over that time period, county unemployment rates were higher than the state average for all but two years. Annual unemployment in Park County peaked in 1982 and declined through 1984, following the state trend as economic conditions slowly improved. Preliminary quarterly data for 1985 show monthly unemployment rates above the 1984 annual average; however, summer employment opportunities will offset first quarter statistics and the annual 1985 employment rate will probably be below that of the first quarter.

Table II-25 shows the number of job applicants by selected skills who applied for work through the job service in Park County for April 1983 and 1985 and November 1983. The active number of job applicants increased between

Table II-24: Park County and Montana Unemployment Rates

Year	Park County (percentage)	Montana (percentage)
First Quarter 1985 (unrevised)		
March	9.6	8.0
February	9.3	8.4
January	11.1	9.2
1984	8.6	7.4
1983	10.6	8.8
1982	10.8	8.6
1981	8.3	6.9
1980	7.1	6.1
1979	5.3	5.1
1978	5.8	6.2
1977	6.6	6.4
1976	5.4	6.1

Source: Montana Department of Labor and Industry, First Quarter 1985, pp. 15-17 and 28-36.

Table II-25: Number of Park County Job Applicants by Selected Skills

Skill Category	Job applicants April 1983[1]	Job applicants November 1983[1]	Job applicants (April 1985)[2] Active	Inactive	Job applicants 55 and over (April 1985)[2] Active	Inactive
Machinists	10	2	5	3	0	2
Auto mechanic	16	18	24	35	1	1
Diesel mechanic	15	10	14	12	1	3
Electrician	5	4	7	13	0	1
Carpenter	29	8	39	44	1	2
Pipefitters/plumbers	5	4	4	10	0	0
Equipment operators	12	8	13	31	0	2
General laborer	95	52	56	102	0	1
Clerical workers	95	52	111	243	15	2
Sawmill workers	20	31	27	42	1	1
Loggers	5	4	15	13	0	1
Assemblers (mining machinery)	2	0	0	1	0	0
TOTAL	297	191	315	549	19	16
Total less clerical applicants	214	141	204	306	4	14

[1] Mountain International, August 1984, p. 35.

[2] Dale Siegle, Manager, Livingston Branch, Job Service Division, Montana Department of Labor and Industry, pers. comm., April 19, 1985.

1983 and 1985. However, if the clerical skill category is subtracted, the number of job applicants remained nearly constant. Although the total number of applicants remained constant, the types of skilled applicants changed over that time period. Job applicants with clerical skills increased the most, from 83 to 111. Applicants listed together as sawmill workers and loggers increased from 25 to 42. The number of general laborer and machinist job applicants declined from 105 to 61.

Employment

Barring another national business downturn or recession, Park County employment should show moderate gains over the next few years. Employment between 1967 and 1982 grew at annual rates up to 4.8 percent; however, during the recent recession annual employment declined at rates up to 3.3 percent. The total annual average change in employment over the entire period was 1.22 percent.

A modest steady growth in employment is forecast for Park County (see table II-26). Most of the growth will occur in the retail trade and services sectors, emphasizing the importance of tourism to county employment. Retail trade employment is estimated to grow from 830 jobs in 1985 to 972 in 2010 (13.4 percent of total employment). Service sector jobs are projected to increase from 980 in 1985 to 1,751 in 2010 (24 percent of total employment). The number of nonfarm proprietors could also increase from 945 in 1985 to 1,588 in 2010 (21.9 percent of total county employment).

Table II-26: Projected Park County Employment (without the Jardine Joint Venture Project)

Place of employment	Year							
	1980 census	1982 BEA data	1985	1990	1995	2000	2005	2010
Agricultural employment	564	568	557	545	538	521	510	498
Mining	10	(L)[1]	12	14	14	14	14	14
Construction	167	219	230	235	261	295	335	380
Manufacturing	380	293	243	257	271	286	302	319
Transportation, communication, and public utilities	928	797	781	710	657	649	641	630
Wholesale trade	41	46	46	50	52	60	60	65
Retail trade	782	812	830	840	870	907	939	972
Finance, insurance and real estate	237	179	183	196	215	236	259	284
Services	942	956	980	1,079	1,218	1,374	1,551	1,751
Nonfarm proprietors	903	945	984	1,123	1,211	1,336	1,437	1,588
Government	680	720	720	730	735	740	750	750
Total employment	5,634	5,536	5,566	5,779	6,042	6,418	6,798	7,251

Source: Department of State Lands, unpublished working papers, May 1985.

Assumptions: Historical growth rates (1967-1982) were used to project employment for each major sector.

[1] Fewer than 10 people were employed in this field.

Agricultural employment is projected to decline over the forecast period following statewide trends. Agricultural jobs (including farm proprietors) are predicted to decline from 557 to 498 jobs, about 10.6 percent.

Employment in the transportation, public utilities, and communication sector--historically the major Park County employer--will decline in importance. By 2010, this sector is expected to contribute 630 jobs (8.7 percent of total employment), down from 781 jobs in 1985 (14 percent of total employment).

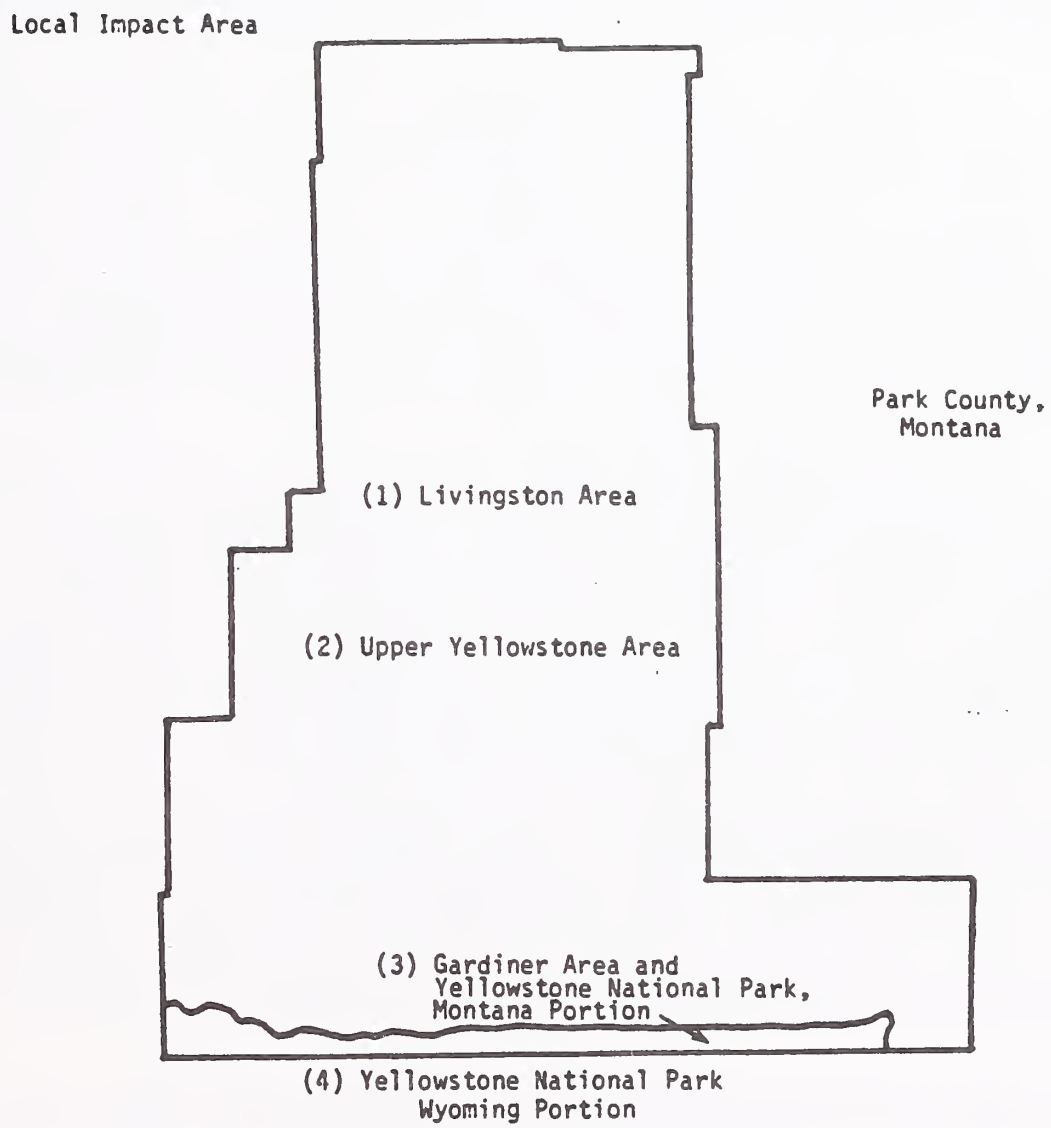
Total employment is projected to increase about 31 percent from 5,536 jobs in 1982 to 7,251 in 2010. Such growth could be too optomistic if the nation slides into another recession. However, employment could increase at a faster pace if economic growth is sustained.

SOCIOLOGY

Demography, social life, and community services each contributes to the sociological scenario of Park County. The proposed project would affect residents in the southern part of the county more substantially than those in the remainder of the county. For purposes of this study, the local impact area will be defined as Park County. The city of Livingston, the Upper Yellowstone Census Division (Paradise Valley), the Gardiner, Cooke City, Yellowstone National Park (Montana portion) Census Divisions, and Yellowstone National Park (Wyoming portion) each will be considered sub-units of the impact area. Existing demographic patterns together with potential impacts will be presented where data exist. The remainder of the county will be treated as one area because the development impact would be minimal. Figure II-25 illustrates the local study areas in Park County.

The Wyoming portion of Yellowstone National Park includes that area north of Yellowstone Lake in Park County, Wyoming, to the Montana border including the community of Mammoth. The close proximity of Mammoth to the Gardiner area and the functional relationship that Mammoth has to the Gardiner demographic/economic environment warrants including this region in the local study area. In 1980, the Yellowstone National Park Census Division in Park County, Wyoming, had 425 inhabitants, about 400 of whom lived in the community of Mammoth, Wyoming. The Gardiner Area Census Division is combined with that portion of Yellowstone National Park in Montana because about half of the 66 residents (1980 census) in this portion of Yellowstone Park actually reside within the park boundaries next to Gardiner (Tom Swan, manager, Administrative Services, National Park Service, Mammoth, Wyoming, pers. comm., May 1985).

Livingston is the major trade center in Park County and over half of the county population resides there. Clyde Park is the only other incorporated community in Park County, but because it is located about 30 miles north of Livingston, it will not be considered as a separate entity in this study.



(1) Livingston Area includes the incorporated town of Livingston.

(2) Upper Yellowstone Area includes the Upper Yellowstone Census Division without Livingston.

(3) Gardiner Area includes the Gardiner - Cooke City Census Division and Yellowstone National Park, Montana Portion.

(4) Yellowstone National Park, Wyoming Portion, includes the community of Mammoth (1980 Census reported 425 persons for the area).

Figure II-25: The local sociological impact areas were divided into three sections of Park County, and one area in northern Yellowstone National Park in Wyoming.

Demography for Park County

In 1980, the U.S. Bureau of the Census reported the population of Park County at 12,869 people, up 15 percent over the 1970 census. The population of Park County has fluctuated little since 1910, peaking in 1960 at 13,168 people. Since 1980, the population has increased slightly. Table II-27 illustrates current population estimates and components of change for Park County from 1980 through 1984.

The population estimates presented in table II-27 are prepared annually by the Bureau of the Census and the Bureau of Business and Economic Research, University of Montana. These estimates are based on county births, deaths, school enrollment, federal income tax returns, and Medicare data. As illustrated, the estimates show an initial increase in 1981 and a stable population base since that time. Park County has experienced a declining economic environment since 1980, (primarily because of the reduction of the Burlington Northern labor force). However, the population has remained fairly constant because enough people move into the area to offset those who may move out due to the economic environment.

The most obvious population influx is associated with the Church Universal and Triumphant. About 200 to 300 people associated with the church have moved into Park County since 1980 (Andy Epple, Park County Planner, pers. comm., May 1985; Ed Francis, President, Royal Teton Ltd./Church Universal and Triumphant, pers. comm., May 1985). Other influx has probably occurred because of retirement and relocation due to the appealing, natural environment. This type of growth in the Upper Yellowstone Valley is an extension of the 1970-1980 growth for the area when the population increased about 10 percent with little or no change in the economic base.

The population density of Park County is 4.8 persons per square mile (1980 census), somewhat lower than the state density of 5.4 persons per square mile. The percent of urban population (those living in incorporated places) in Park County is about the same as the state average of 53 percent. In 1980, 98 percent of the Park County population was classified as white and the median age was about 34 years for females and 32 years for males.

Table II-27: Estimated Population and Component Changes for Park County, Montana

Year	Population	Actual births	Actual deaths	Estimated migration
1980	12,869	--	--	--
1981	13,300	219	125	337
1982	13,200	206	133	-173
1983	13,300	179	150	71
1984	13,400	211	143	32

Sources: U.S. Department of Commerce, Bureau of the Census, Local Population Estimates, Series P-26, No. 84-52-C, March 1985. Montana Department of Health and Environmental Sciences, Vital Records and Statistics Bureau, Annual Reports.

The number of households in Park County in 1980 was 4,924, with an average household size of 2.54 persons. This average is a slight decrease from the 1970 size of 2.8 and is significantly smaller than the 1980 average state household size of 3.1 persons.

Residents of Park County near the state norm in education, with 75 percent of the people completing 12 years or more of school. The percentage of county residents completing 16 years of more of school is about 14 percent, slightly lower than the state average of 17.5 percent.

Demography for Park County Communities

From 1910 to 1970, the population of Livingston fluctuated in much the same manner as the county. However, from 1970 to 1980, while Park County grew nearly 15 percent, the population of Livingston increased only 2 percent. Table II-28 illustrates the past growth and current trends from 1980 to 1984.

As shown in table II-28, nearly all of the growth from 1970 to 1980 within Park County occurred in the Upper Yellowstone Census Division and in the Gardiner area. The 1984 estimates were calculated using extensions of this growth and were controlled by the county total estimate illustrated in table II-27. The 1980-84 Gardiner area growth is entirely attributable to members of the Church Universal and Triumphant moving into the area.

Selected demographic characteristics for local communities within the study area are presented in table II-29. Within Park County, the average household size ranges from 2.79 in the Upper Yellowstone Valley to 2.34 in the Gardiner area. Both the Gardiner and Upper Yellowstone areas have a smaller proportion of people over the age of 65 than does Livingston. The median age in these 2 areas is 3 to 4 years younger than Livingston. The median family income for all areas in Park County is nearly the same; however, this data is based on a 20 percent sample of the 1980 census.

Table II-28: Local Area Population Estimates for the Jardine Study Area

Place	Census 1970	Census 1980	Estimated 1984	Percentage change 1980-84
Park County	11,197	12,869	13,400	4.1
Livingston	6,883	6,994	7,150	2.2
Gardiner Area	909	1,135	1,250	10.1
Upper Yellowstone Area	1,661	3,335	3,550	9.4
Remainder of County	1,808	1,471	1,450	-1.5
YNP/Wyoming[1]	400	425	425	0

[1] Note: Yellowstone National Park/Wyoming includes Mammoth with an estimated 1980 population of 400.

Table II-29: Selected Demographic Characteristics of the Jardine Study Area (1980 Census)

Characteristic	Park County	Livingston	Upper Yellowstone	Gardiner area
Households	4,924	2,843	1,197	485
Persons per household	2.54	2.41	2.79	2.34
Age characteristics:				
Percent				
Under 18	26.8	25.2	30.4	23.1
18-64	58.7	56.8	60.3	66.4
65 and over	14.5	18.0	9.3	10.5
Median age	32.7	34.4	30.0	31.3
Median family income	$18,042	$18,852	$19,040	$18,688

Source: U.S. Census Bureau, 1980.
Note: The Gardiner area statistics are a weighted average of the Gardiner-Cooke City Census Division and Yellowstone National Park Division (Montana portion).

Population Projections

The population of Park County is estimated to increase about 5.6 percent over the next 10 years and 11.4 percent over the next 20 years (see table II-30). These projections are consistent with those developed by the Census and Economic Information Center, Montana Department of Commerce (13,900 in 1990 and 14,700 in 2000). Estimates in table II-30 and those of the Census and Economic Information Center are 800 to 1,000 persons higher than baseline projections published in the Jardine Joint Venture (JJV) Mitigation Plan (Mountain International, Inc., 1984). However, the annual county growth rates associated with that set of projections are consistent with the growth rates in table II-30. The major difference between JJV mitigation plan projections and the other two is that the JJV plan assumes that a higher number of unemployed workers will leave Park County in search of work than do the other two forecasts.

The baseline projections produced for the sub-county areas use the 1980 distribution of population in Park County and the 1970-80 area growth rates. These local area projections are calibrated according to 1984 population estimates and projected county totals.

Social Life

(Information on social life was taken predominantly from the Social Life sections in Volumes I and II of the socioeconomic reports prepared for the JJV Hard Rock Impact Mitigation Plan by Mountain International, Inc. [1984].)

Mining began in southern Park County in 1866, when gold was discovered in Bear Creek near the present site of Gardiner. In 1880, a post office was established at Gardiner. The Bear Gulch Company opened the Jardine Mine in

Table II-30: Baseline Population Projections for Local Impact Areas in Park County[1]

Year	Park County and YNP Wyoming	Livingston	Upper Yellowstone	Gardiner area	YNP Wyoming
1980	12,869	6,994	3,335	1,135	425
1984	13,400	7,150	3,650	1,250	425
Projections					
1985[2]	13,200	7,050	3,500	1,300	145
1990	13,600	7,150	3,750	1,350	425
1995	13,950	7,200	4,000	1,400	425
2000	14,350	7,250	4,250	1,450	425
2005	14,700	7,350	4,500	1,500	425
2010	15,100	7,400	4,800	1,550	425

Note: The Shields Valley Division (not shown) is forecast to remain at the same level over the projection period.

[1]The baseline (without project) projections are the product of a demographic/economic simulation model that uses projected labor force participation by age and sex rates and cohort survival techniques of county population by 5-year intervals to the year 2010. Cohort survival refers to the estimated mortality rates of persons by age category. For example, statistically, persons 20 to 30 years old are more likely to survive an additional year than persons aged 60 to 70. As illustrated, the projections represent an annualized growth rate of about 1 percent--equal to stable or no growth scenario.

[2]The 1984-85 decrease for Livingston and Park County reflects the expected out-migration related to the current economic environment.

1899. Gardiner became a primary gateway to Yellowstone Park, the outfitting point for the mines in Bear and Crevice gulches, and the commercial center for southern Park County.

The construction of the Northern Pacific Railroad and the creation of Yellowstone National Park shaped the history of Park County, and the Gardiner area in particular. The railroad created the city of Livingston, which remains the county seat and the largest community in Park County. The railroad has been the largest single employer in Park County since it entered the county in 1882. Gardiner has depended on the Park and the tourism it generates.

Survey Methods. In 1981, individuals in 204 households were surveyed by interviewers using a questionnaire designed to learn opinions regarding the nature and quality of life in the study area. Surveyed households were selected at random to assure the survey respondents were representative of area residents. The area surveyed approximated the combined Gardiner and Mammoth elementary school districts. It included Mammoth and Gardiner communities plus the rural areas east, west, and north of Gardiner incorporating Jardine, Tom Miner Basin, Cinnabar Basin, and households along Highway 89 to Point of

Rocks. All households along the Jardine Road from the edge of Gardiner to the proposed minesite were included in the survey because residents of the area live near the proposed project.

In April 1985, additional interviews were conducted in the Gardiner area and Livingston to learn about the concerns associated with the Jardine Joint Venture Project. Interviews were held with the Park County Commissioners, Park County Planning Board, the Gardiner Chamber of Commerce, members of the former Gardiner Area Planning Advisory Group, the Bear Creek Council, local business people, the Park County Sheriff, Park County Planner, and Gardiner School Superintendent.

The residents surveyed in 1981 ranked characteristics of the area they liked best from a list of 16 choices; nearly all the survey participants ranked the natural environment as the best. They ranked the other top characteristics in the following order: slow-paced life; friendliness of residents; quiet, solitude, and privacy; and sparse population. All surveyed Jardine residents rated quiet, solitude, and privacy very high (Mountain International, Inc., 1985, unpublished survey data).

Mammoth residents ranked recreational opportunities higher than other residents, placing it as the second most important characteristic. Most Mammoth residents do not intend to stay in the area permanently, whereas most Gardiner area residents plan to remain the rest of their lives.

When interviewed in 1981, area informants identified three traits characteristic of the Gardiner area--appreciation of the natural environment, individualism and self-sufficiency, and economic security. The importance of the natural environment involves three themes: appreciation of the grandeur, beauty, and bounty of the region; recognition of the importance of the natural environment in creating and sustaining the local economy; and use of the natural environment both as a source of direct sustenance (for example, firewood and game meat) and for recreation.

In Gardiner, work is performed to allow families to sustain themselves and maintain residences in the area and not necessarily to obtain a high standard of material living. Many Gardiner area residents are employed in seasonal jobs; a large number combine work in Yellowstone National Park with odd jobs for other public and private employers, and subsistence activities to make a living. By contrast, Mammoth residents typically are employed full time and are career-oriented. Good-paying, full-time jobs are rare and desirable in Gardiner.

There is a strong conservation ethic in the Gardiner area and an expectation that a developer be both sensitive to environmental considerations and a steward of the land. There is a difference, however, between Gardiner and Mammoth residents' attitudes in the way in which the resources of the natural environment are to be enjoyed. Gardiner residents generally have a more utilitarian view, seeing the natural environment as a resource to be harvested, though with respect. Mammoth residents exhibit a more preservationist view.

Social Structure and Interaction. Gardiner area survey respondents generally described Gardiner as an aggregate of many social groups, with interaction between individuals of the different social groups being casual and informal. Local groups and businesses have little power in the Gardiner area because the business community and major employers are almost completely from outside the area. Gardiner is not incorporated, and many decisions regarding the community are made by the Park County government.

There are several sources of discord among Gardiner area residents. Some conflict arises between residents of Gardiner and Mammoth regarding the appropriate use of the natural environment. Some conflict also exists depending on residents' opinions regarding the project. Divisiveness also occurs due to residents' attitudes regarding the Church Universal and Triumphant.

Social Institutions: Economic Life. The majority of residents surveyed described the Gardiner economy as stable. It is based on the maintenance of and tourism generated by Yellowstone National Park. The federal government is the primary employer in the Gardiner area and also controls most of the area land base. In addition, many Gardiner businesses are operated by absentee owners who generally participate in the community only during the summer. The primary source of income other than government employment is tourist spending. Four factors shape the Gardiner area economy: seasonal cycles based on a four-month tourist season; service sector employment; extra-local influences; and constraints on economic development from the geography, climate, and transportation system of the area.

The Gardiner economy is influenced heavily by outside control. Except for the school system and a few businesses, all economic activity is either directed toward tourists or is generated by institutions with a regional or national orientation. This extra-local orientation of the economy appears to be a source of community tension. Some Park County residents are also concerned about the economic power of the Church Universal and Triumphant because it does not depend on the region economy.

Social Problems. Alcohol abuse was considered the most common social problem in the Gardiner area when research was conducted in 1981. Teenage drinking was identified as the second most prevalent social problem locally, while traffic offenses ranked third and divorce fourth. Drug abuse, although ranked fifth, does not appear to be a particularly significant problem among the county's indigenous population, according to survey respondents.

Crime ranked eighth in prevalence of the 10 social problems residents were asked about in 1981. The Park County rate of felonies has generally been below the state average. Felonious criminal activity was regarded as rare in the immediate Gardiner area during the winter months except for antler collecting, which refers to removing antlers from Yellowstone National Park. People hunting antlers sometimes poach big game or destroy wildlife to obtain the antlers. In the summer, criminal activity increases with the arrival of seasonal workers and tourists. Crimes committed during the summer are typically disturbances, drug offenses, and theft.

Attitudes and Concerns. When area residents were surveyed in 1981, they were asked how they felt about outsiders moving into the area. The majority

(52 percent) of the residents of Gardiner, Jardine, and the other rural areas near Gardiner said they would not mind, 23 percent said they would welcome them, and 23 percent said they would prefer not to have them. In Mammoth, 57 percent said they would welcome outsiders, 30 percent said they would not mind, and 11 percent said they would prefer not to have them (Mountain International, Inc., 1985, unpublished survey data).

Community Services

Community services provided by Park County, the National Park Service, and the municipalities of Livingston and Gardiner would be the most likely to be affected by the proposed project. The following community services currently exist in the study area and would probably be more heavily used with construction and operation of the proposed project.

Education. Projected school enrollment between 1984 and 1990 for Park County as a whole is expected to increase by about 151 students in all grades without the proposed project (Mountain International, Inc., 1984, vol. III, p. 33). Livingston, over the last five years, has enrolled about 70 percent of all the elementary and middle school students in Park County and about 78 percent of the secondary students of the county (Mountain International, Inc., 1984, vol. III, p. 28). Future trends in student enrollment in Livingston, as compared to Park County as a whole, are not expected to change significantly.

Schools in the Gardiner area are the Gardiner Elementary School, the Gardiner High School, and the elementary schools in Mammoth, Wyoming (Yellowstone National Park), and Cooke City, Montana. Enrollment in the 1982-83 school year was 119 in the Gardiner Elementary School and 88 in the high school (Mountain International, Inc., 1984, vol. I, p. 165).

Between 1984 and 1990, enrollment is expected to gradually increase in grades K through 6 by about 15 students and decrease in grades 7 and 8 by about 10 students. High school enrollment is projected to reach a peak in 1985-86, and decline by about 46 students by 1990 (John Fitzpatrick, Consultant, Mountain International, Inc., pers. comm., April 17, 1985). An increase in elementary enrollment by 80 students would reach the functional capacity of the school, while the high school could accommodate another 20 to 25 students without additional teachers and curriculum modifications (Mountain International, Inc., 1984, vol. I, pp. 167-168).

Education in Livingston is provided by 3 elementary schools, 1 middle school, a Catholic parochial elementary school, 1 high school, and a special education center. Based on 1982-83 classroom configurations, the Livingston elementary schools could accommodate an additional 159 students in grades 1 through 5 and the high school and middle school could each facilitate 200 more students with the addition of the necessary teaching and support staff (Mountain International, Inc., 1984, vol. III, pp. 30-31). High school students from Springdale, Richland, Pine Creek, and Arrowhead school districts attend school in Livingston (John Overstreet, principal, Gardiner Public School, pers. comm., May 1985).

Schools in Park County, other than those in Livingston and Gardiner, that could be affected by the proposed project are three rural elementary schools in the Upper Yellowstone Valley (Arrowhead, Pine Creek, and Richland). Present (May 1985) school enrollment is 14 students at Richland, 27 students at Pine Creek, and 51 students at Arrowhead. Due to a decrease in enrollment at Richland and Arrowhead schools, a teacher at each school will be laid off at the end of this school year (Sonja Spannring, Park County Superintendent of Schools, pers. comm., May 1985). Depending on the location of in-migrating mine employees and the number and age of their children, these schools could accommodate an increase in enrollment.

Law Enforcement. Law enforcement services in Park County are provided by the Montana Highway Patrol, the Park County sheriff's department, the National Park Service, and the Livingston police department. Three state highway patrol officers are based in Livingston and patrol the major roads and highways in Park County and adjacent areas. The sheriff's department serves the rural areas including Gardiner, Cooke City, Clyde Park, and Wilsall. The jurisdiction of the Livingston police is confined to the city limits of Livingston. National Park Service Rangers patrol Yellowstone Park and a portion of Gardiner lying within the legal boundary of the park.

Of the total equivalent of 9.5 full-time officers, the Park County sheriff's department has 2 deputies stationed year-round in Gardiner and 1 in Cooke City during the summer tourist season (Bob Oakland, Park County sheriff, pers. comm., April 1984). Additional special deputies can be activated as necessary from a support pool of seven reserve officers (park rangers). Although there are no formal agreements between the National Park Service and the sheriff's department, both groups work together and coordinate activities to mutual benefit.

Statistics show that the current Park County Sheriff's Department has a higher number of officers than selected counties with comparable populations such as Custer, Dawson, Fergus, and Hill counties. Officers in Park County, in general, patrol fewer miles of road and smaller areas of land than do their counterparts in similarly sized Montana counties (Mountain International, Inc., 1984, vol. I, p. 171). The county sheriff and other citizens believe that another deputy is needed in Gardiner at the present time (Bob Oakland, Park County sheriff; Gardiner Chamber of Commerce; Dave Schreiber, member, Gardiner Concerned Citizens; Park County Planning Board, all pers. comm., April 1985). In a 1981 survey conducted by Mountain International, 77 of the 111 Gardiner respondents thought that the police services were poor. However, no qualitative judgement regarding the workload of Park County officers can be determined from such statistics.

The Livingston police department has a full-time staff of 10 officers, and shares office, dispatch, and jail facilities in the City-County Municipal Building with the sheriff's department. Eight of the 10 officers are assigned to street patrol on a regular basis (Bonnie Waters, dispatcher, Livingston police department, pers. comm., May 1985).

Fire Protection. There are five rural fire districts in Park County (Livingston, Cooke City, Clyde Park, Wilsall, and Gardiner). Presently, the county is trying to form two more districts so that the entire area from Livingston to Gardiner would be covered (Carlo Cieri, Park County commissioner, pers. comm., May 1985).

Ten paid firefighters, backed up by 12 volunteers, provide 24-hour fire protection for the city of Livingston. The fire department currently owns 3 pumper trucks (1 with an 85-foot ladder), 1 rescue van, 1 pickup with a monitor, more than 3,000 feet of hose, extractive equipment, smoke ejector units, and portable breathing apparatuses (David Frederick, firefighter, Livingston fire department, pers. comm., May 1985). Although the fire department primarily serves the city of Livingston, it also provides support service for rural Park County, Big Timber, and Yellowstone National Park. On a scale from 1 to 10 with Class 1 being the highest rating, the present fire protection rating is Class 7 (Earl Huestis, field representative, Insurance Service Organization, pers. comm., May 1985).

Gardiner is served by 15 to 25 volunteer firefighters (Gene Kremer, Gardiner volunteer firefighter, pers. comm., April 1985). The fire department has three fire engines with capacities of 750 gallons, 500 gallons, and 300 gallons (Mountain International, Inc., 1984, Mitigation Plan, pp. 95-96). The department has a Class 7 fire protection rating (Earl Huestis, field representative, Insurance Service Organization, pers. comm., May 1985).

Additional rural protection is provided by the Gallatin National Forest, the National Park Service, and the Department of State Lands Forestry Division. The National Park Service houses fire protection equipment at Mammoth to provide service throughout Yellowstone National Park including the warehouse/shop compound located at Gardiner (Mountain International, Inc., 1984, Mitigation Plan, p. 95).

Ambulance. Ambulance services in the Gardiner area are provided by 10 volunteers (2 of whom are certified emergency medical technicians) affiliated with the volunteer fire department. The radio-equipped ambulance is a 1972 van modified and equipped to provide emergency medical aid. Fees for services and donations pay for the ambulance and emergency services (Mountain International, Inc., 1984, Mitigation Plan, p. 122).

The average number of emergency calls answered annually by the Gardiner ambulance is between 25 and 35 (Gene Kremer, Gardiner volunteer firefighter, pers. comm., April 1985). In a 1981 survey conducted by Mountain International, 85 of the 111 Gardiner respondents rated the ambulance service as moderate, good, or excellent.

Yellowstone National Park has 2 ambulances and 9 to 10 Park Service personnel stationed at Mammoth who provide emergency services. Although the Park Service emergency services are funded for primary use within the Park, aid is provided outside the park boundary in response to major emergencies or when the Gardiner ambulance is not available (Mountain International, Inc., 1984, Mitigation Plan, p. 122).

A private ambulance firm (Community Lifeline), operating three ambulances, serves Park County and has a contract with Yellowstone National Park to provide emergency services. The company employs 15 persons (five emergency medical technicians and the remainder advanced first aid, six-month probation people) (Mark Christensen, owner, Community Lifeline, pers. comm., May 1985). Fixed-wing aircraft and helicopters, operated by Saint Vincent and Deaconess hospitals in Billings, provide air ambulance service throughout Park County (Mountain International, Inc., 1984, vol. I, p. 189).

Hospital and Medical Personnel. The Livingston Memorial Hospital, a 54-bed acute care facility staffed by 100 to 115 full-time employees, is the only hospital in Park County and adjacent Yellowstone Park. As of February 1985, there were 15 active physicians (including 1 pathologist, 1 radiologist, and a few Bozeman doctors) associated with the hospital, 26 full-time registered nursing positions, 3.5 full-time license practical nursing positions, and 1.5 full-time pharmacist positions (Jacqueline McKnight, Chief, Licensing and Certification Bureau, Montana Department of Health and Environmental Sciences, pers. comm., May 1985). The existing number of medical staff are considered to be adequate; however, with or without the project, the physical facility should be replaced (Richard Brown, Administrator, Livingston Memorial Hospital, pers. comm., May 1985). In 1980, the occupancy rate of the hospital was 42 percent (Mountain International, Inc., 1984, vol. I, p. 186). Presently, the hospital is not operating at capacity.

About 80 percent of the hospital patients were from Livingston in 1979, and 4 percent (about 52 patients) were from Gardiner. About 39 Gardiner patients also used the Bozeman Deaconess Hospital in 1979 (Mountain International, Inc., 1984, vol. I, pp. 185-186).

No physicians reside in the Gardiner area (Park County Commissioners, pers. comm., April 1985). The city of Livingston, however, has a total of 10 doctors--1 at the Livingston Clinic, 1 at the Yellowstone River Family Medical Center, 7 at the Park Clinic, and 1 independent (Betty Fischer, receptionist, Livingston Clinic, pers. comm., May 1985; Melva McCure, file clerk, Park Clinic, pers. comm., May 1985).

A medical clinic, owned by the National Park Service, is operated during the summer tourist season in Mammoth (Mountain International, Inc., 1984, vol. I, p. 186). The facility is staffed by a physician's assistant, a registered nurse, and a secretary. It is equipped to handle emergencies and short-term care on a limited basis (i.e., 1 room for short-term observation/stabilization) (Mountain International, Inc., 1984, vol. I, p. 186).

Water Supply. Public water supplies for Livingston and Gardiner are obtained from either ground water, the Yellowstone River, or both. Gardiner's primary water source at present is a 225- to 250-gallon per minute (gpm) spring and the secondary source is a 350-gpm pumping and treatment facility on the Yellowstone River. The development of new wells (500-gpm projected capacity) is underway to provide a new laundry complex in Yellowstone Park with water and a more reliable source of water for Gardiner.

Livingston has relied upon both pumped ground water and treated water from the Yellowstone River. In 1982, however, the Yellowstone River treatment plant was permanently closed. Currently, Livingston relies solely on wells and has experienced water shortages during the peak summer irrigation season (Jerry Burns, Water Quality Bureau, Montana Department of Health and Environmental Sciences, pers. comm., April 1985). The construction of new wells should be completed by 1986 and would thereby alleviate water shortages (John Connell, Engineer, Christian-Spring-Sielbach and Associates, pers. comm., April 1985).

Rural water supplies throughout Park County are predominantly private wells. It does not appear that the construction and operation of additional private wells would inhibit suburban development in the Upper Yellowstone Valley.

Water availability for fire protection in Gardiner currently meets the minimum standards promulgated by the National Board of Fire Underwriters, even during the peak periods of water consumption in August (Mountain International, Inc., 1984, Mitigation Plan, p. 100). With the development of new wells, adequate fire flows (a measurement of the capacity of a water system to provide water for firefighters) would be ensured.

Wastewater Treatment. Sewage facilities serving Gardiner and Mammoth, Wyoming, are composed of an aerated sewage lagoon system with chlorination units for treating effluent discharge from the lagoons. Because the facility is approaching the end of the designed 20-year life span and is in need of repair, the existing facility will have to be refurbished and expanded to adequately provide future service with or without the proposed project (Bill Enright, assistant office manager--Billings Office, Morrison-Maierle, Inc., pers. comm., April 1985). The additional demand imposed by the new laundry complex in Yellowstone Park would bring the system up to about 80 to 85 percent capacity (Dave Holland, operator, Gardiner Wastewater Treatment Plant, pers. comm., May 1985). Furthermore, addition of up to 75 families (or about 200 individuals) coupled with the new laundry could bring the system to capacity for reliability purposes (Bill Enright, assistant office manager--Billing Office, Morrison-Maierle, Inc., pers. comm., April 1985). The system capacity should be adequate until 2005, based on Gardiner population estimates (see table II-30).

The current Livingston wastewater treatment plant began operation in 1981 and presently is in a stable operational mode, producing a high-quality effluent. The facility serves a population of 9,000 with a designed capacity of 10,500 (Montana Department of Health and Environmental Sciences, Evaluation Report, April 17, 1984).

Solid Waste. Solid waste is collected and disposed of throughout Park County under the supervision of a county-wide disposal district (Mountain International, Inc., 1984, vol. I, pp. 203-04) and paid for by the users. Collection bins (green boxes) are situated in various locations throughout Livingston and the county where refuse is deposited by residents and collected by a truck mounted with a compactor. In Gardiner, there are 34 green boxes located in one spot. These boxes are surrounded by a chain link fence and have been "bear-proofed." Refuse is hauled to Livingston where it is burned

in an incinerator. The National Park Service also collects solid waste from Yellowstone National Park and Cooke City and transports it to the Livingston incinerator for disposal.

Currently the incinerator burns about 50 to 60 tons per day with a capacity of 72 tons per day. The Park County landfill is used for disposal of metals (pig iron) and ash from the incinerator. An estimated 10 acres have been used with 30 acres still remaining (Ed Flatt, operator/manager, Park County Incinerator, pers. comm., May 1985).

Social Welfare. Social welfare programs in Park County are administered with funds coming from state, federal, and county sources. The social welfare programs offered through Park County include:

1) aid to families with dependent children,
2) medicaid and county medical assistance,
3) foster care,
4) food stamps,
5) social services,
6) general assistance,
7) transient assistance, and
8) visual services/vocational rehabilitation

The Park County Welfare Office is located in Livingston; Gardiner residents conduct business through the mail or drive to Livingston.

Housing. The number of available housing units for sale or rent in Gardiner is very limited. There are 7 or 8 homes listed for sale by 12 of the 13 Park County realtors and about 5 for sale by owners (Andy Epple, Park County planner, pers. comm., May 3, 1985).

Mobile home courts with facilities for year-round occupancy are nonexistent in the Gardiner area but there are three campgrounds--Rocky Mountain Campground and Paradise Campground in Gardiner, and Cinnabar Campground in Corwin Springs. The Rocky Mountain Campground has 13 permanent mobile home sites which are currently occupied; there are no plans to increase the number of available equipped lots (Bob Rucker, owner, Rocky Mountain Campground, pers. comm., May 1985). The other two campgrounds are designed for overnighters and there are no plans to add any permanent mobile home lots (Marsha Beese, owner, Cinnabar Campground, pers. comm., May 1985; Virginia Dowdy, owner, Paradise Campground, pers. comm., May 1985). The overnight trade produces more money and has fewer maintenance problems (Bob Rucker, owner, Rocky Mountain Campground, pers. comm., May 1985).

Small tract homesites near Gardiner that currently are for sale include:

1) about 10 small tract homesites in Gardiner (including four in the Sunny Slopes Subdivision),
2) about 40 undeveloped 20-acre tracts near Point of Rocks, and
3) more than 100 small undeveloped tracts in the Upper Yellowstone Valley.

In Livingston, there is an ample supply of relatively inexpensive housing available (Andy Epple, Park County Planner, pers. comm., May 3, 1985).

FISCAL CONDITIONS

Park County

Property tax revenues are the single largest source of revenue for Park County. Property taxes contributed 48.2 percent of total county general fund revenues in fiscal year 1983-1984 (FY84) and 37.7 percent in FY85. However, the percentages of property tax revenue to total revenue for Park County are below statewide averages for all counties, which were 49.8 percent in FY84 and 47.7 in FY85 (Montana Association of Counties, 1985). Growth in Park County revenues during the 1970s was due primarily to increases in intergovernmental transfers (Mountain International, Inc., 1984, vol. 1, p. 325).

Table II-31 shows Park County expenditures by major fund, and the total for all funds for selected fiscal years between 1971 and 1985. The per capita expenditures from these funds are also listed by nominal dollars (not adjusted for inflation) and constant dollars adjusted for inflation to a 1980 base.

Nominal general fund spending has increased from $301,708 in FY71 to $1,043,162 in FY85, a 250 percent increase over 15 years. However, not all of the increase was due to real growth in expenses. Much of the increase was the result of inflation which caused governments to raise expenditures. The effect of inflation on general fund expenses is illustrated by comparing per capita general fund expenditures in nominal or current dollars and constant dollars that have been adjusted for inflation since 1980 (see table II-31). While nominal per capita, general fund expenditures more than tripled over the 15-year period ($26.95 in FY71 to $81.06 in FY85), real expenditures increased only 33 percent from $49.94 in FY71 to $66.38 in FY85.

General fund expenses accounted for almost half of total county expenditures in FY85. Together the road and bridge funds make up the second largest category, comprising nearly one-third of total FY85 expenditures. While nominal per capita expenditures for the Park County road and bridge funds more than doubled between 1971 and 1985, the real inflation-adjusted per capita expenditures varied between $31.00 and $40.00 over that time period (see table II-31).

The poor fund has been the third largest county expense since FY80. However, Park County recently opted for state assumption and control of county welfare programs. Under state assumption, a county must levy 13.5 mills for the poor fund, and remit all poor fund revenues to the state. All poor fund expenses are paid by the state even if such amounts are above the revenues generated. Real per capita costs for the poor fund have ranged from $17.00 in FY71 to $1.17 in FY85.

Over the most recent five years, total county expenditures have remained fairly constant, varying from a low of $2.13 million in FY80 to a high of

Table II-31: Park County Expenditures by Major Fund, Selected Fiscal Years 1971-1985

Fiscal year	General Fund: Total amount	General Fund: Mills	General Fund: Per capita expenditure[1]: Nominal dollars	General Fund: Per capita expenditure[1]: 1980 dollars[2]	Road and Bridge Funds: Total amount	Road and Bridge Funds: Mills	Road and Bridge Funds: Per capita expenditure[1]: Nominal dollars	Road and Bridge Funds: Per capita expenditure[1]: 1980 dollars[2]	Poor Fund: Total amount	Poor Fund: Mills	Poor Fund: Per capita expenditure[1]: Nominal dollars	Poor Fund: Per capita expenditure[1]: 1980 dollars[2]	All Funds[3]: Total amount	All Funds[3]: Mills	All Funds[3]: Per Capita Expenditure[1]: Nominal dollars	All Funds[3]: Per Capita Expenditure[1]: 1980 dollars[2]
1985	$1,043,162	26.25	$81.06	$66.38	$587,869	22.0	$45.68	$37.40	$ 18,361	10.36	$1.43	$1.17	$2,152,926	79.38	$167.30	$136.99
1984	1,036,046	27.0	80.51	65.93	631,757	20.0	49.09	40.20	92,522	2.5	7.19	5.89	2,337,267	73.70	181.62	148.72
1983	1,088,356	24.89	84.57	70.87	556,659	19.0	43.26	36.25	205,578	8.65	15.97	13.38	2,192,703	63.63	170.39	142.79
1982	1,009,520	21.0	78.45	68.17	568,088	19.0	44.14	38.35	212,723	9.14	16.53	14.36	2,130,113	59.60	165.52	143.83
1980	599,771	23.0	46.61	46.61	401,480	13.8	31.20	31.20	105,351	5.5	8.19	8.19	1,332,858	51.81	119.04	119.04
1975	438,704	18.3	39.18	55.44	250,596	13.5	22.38	31.67	84,084	3.0	7.51	10.63	890,270	42.46	79.51	112.51
1971	301,708	19.0	26.95	49.94	234,820	15.0	20.97	38.86	101,524	7.0	9.07	16.81	687,419	44.37	61.39	113.76

Sources: Montana Association of Counties, January, 1985. Montana Tax Foundation, Inc., 1985, p. 23. Mountain International, Inc., 1984, vol. 1 p. 309.

[1]Per capita expenditures for fiscal years 1970 and 1975 are based on the 1970 Park County population census count of 11,197. All other fiscal year per capita expenditures are based on the 1980 population census count of 12,869.

[2]Expenditures have been deflated using the implicit price deflator for state and local government expenditures, Survey of Current Business, July issues, 1975, 1977, 1979, 1982, and 1984.

[3]The total for all funds does not include the expenditures from the Planning, Hospital, Ag Extension, or Health and Sanitation Funds in fiscal years 1984 and 1985.

$2.34 million in FY84. The current FY85 budget is $2.15 million. Total real per capita expenditures have ranged from $119.04 to $148.72 over the last five years.

The total taxable value of Park County has not kept pace with inflation over the period of 1972 to 1984 (see table II-32). While nominal growth (not adjusted for inflation) has averaged 2 percent annually from FY72 to FY85, real inflation-adjusted taxable valuation has declined from $24.68 million in FY72 to $15.03 million in FY85, slightly over 3 percent annually.

Statewide taxable valuation has kept pace with inflation although just barely. While the nominal value of total taxable value increased at an annual rate of 6.5 percent, inflation-adjusted, taxable valuation increased only 0.7 percent annually from 1972 to 1985 (see table II-32).

Mill levies in Park County and statewide have increased between FY70 and FY85. Inflation has driven up the cost of government services, while the real taxable value of property has declined. Mill levies have increased 44 percent statewide since 1970 due to these circumstances (Mountain International, 1984, vol. 1, p. 302). Mill levies in Park County have increased 79 percent from 44.37 mills in FY71 to 79.38 mills in FY85 (Montana Tax Association, 1985 and 1971).

Gardiner

Gardiner is not incorporated; therefore, it does not tax property or provide any government services. Special districts provide services such as fire protection, water supply, and street service. Such services could be assumed by Gardiner if it incorporated (Mountain International, Inc., 1984, vol. 1, p. 305). Several jurisdictions levy taxes on property in Gardiner. Table II-33 presents total mill levies imposed on property in Gardiner for selected fiscal years from 1970 to 1985.

Special district levies have fluctuated widely from a low of 51 mills in FY70 to a high of 397.50 mills in FY75. The 1975 levy was exceptionally high due to capital expenditures (Mountain International, Inc., 1984, vol. 1, p. 305). Total special district levies were 99.0 in FY85.

The county-wide school levy is the single largest levy on property in Gardiner (see table II-33). This levy includes the 40-mill county share of state equalization funds for the School Foundation Program and varied amounts for teacher retirement and transportation.

The county levy supports the general and special functions provided by the county. The statewide levy is a 6-mill tax which funds the University System.

School district mill levies have declined 8.2 percent between FY70 and FY85. This decrease occurred because the voted all-purpose levy for school operations was eliminated (Mountain International, Inc., 1984, vol. 1, p. 305).

Table II-32: Taxable Value of Park County and Montana for Fiscal Years 1972-1985 (in millions)

Fiscal	Park County		Montana	
Year	Nominal dollars	1980 dollars	Nominal dollars	1980 dollars
1985	$18.36	$15.03	$2,330.82	$1,908.59
1984	17.41	14.26	2,242.08	1,835.92
1983	17.83	14.94	2,204.49	1,847.40
1982	18.80	16.34	2,013.31	1,749.43
1981	19.13	17.61	1,845.01	1,697.98
1980	17.47	17.47	1,621.95	1,621.95
1979	16.43	18.10	1,568.29	1,727.53
1978	16.47	19.77	1,466.64	1,760.76
1977	16.27	20.91	1,391.94	1,788.64
1976	17.36	23.59	1,350.77	1,835.90
1975	16.18	22.89	1,198.51	1,695.92
1974	14.96	22.91	1,061.12	1,624.81
1973	14.24	24.16	995.10	1,688.00
1972	13.79	24.68	965.71	1,728.62
Average annual rate of change	2.06%	(-3.06%)	6.49%	0.7%

Sources: Montana Association of Counties, January 1985. Mountain International, Inc., 1984, vol. 1, p. 300. Survey of Current Business, July 1975, July 1977, July 1979, July 1982, and July 1984, gross national product implicit price deflator for state and local governments.

Gardiner School Districts

Gardiner has two school districts--elementary district #7 and high school district #4. Student grades 7 to 12 from Mammoth attend Gardiner schools. Payments in lieu of taxes (PILT) from the National Park Service cover educational costs for these students.

Table II-34 shows the elementary school district general fund budget and revenue sources by fiscal year from 1972 to 1983. The largest source of general fund revenue is the state School Foundation Program, accounting for 64.5 percent of the total district #7 budget in FY83.

The second largest source of district #7 revenue is the PILT from the federal government for students from Mammoth, Wyoming. In FY83, this payment amounted to 18.3 percent of the Gardiner elementary district budget. If payments for Mammoth students were not available, district levies would need to increase 93.1 mills in order to raise sufficient operating funds (Mountain International, Inc., 1984, vol. 1, p. 322).

District #7 general fund expenditures per regularly enrolled full-time student increased steadily when measured in nominal dollars (not adjusted for inflation) (see table II-34). Such spending increased 345 percent between FY72 and FY83. However, the average annual inflation rate in state and local expenditures from 1972 to 1983 was 7.51 percent (Survey of Current Business,

Table II-33: Gardiner Property Tax Mill Levies Selected Fiscal Years

Jurisdiction	1970	1975	1980	1982	1983	1984	1985
State	8.20	6.00	6.00	6.00	6.00	5.86	6.00
County	37.17	42.46	51.81	59.90	65.75	73.70	79.38
County-wide general school	50.37	52.48	68.85	77.25	83.19	97.66	95.67
School district	60.72	60.80	36.54	41.93	33.52	55.85	55.74
Special districts	51.00	397.50	75.04	109.36	126.07	90.14	109.00
Miscellaneous	.65	1.40	1.50	4.80	4.65	NA	NA
TOTAL	208.11	560.64	239.74	299.24	319.18	323.21	345.79
Average for communities under 500 population	188.70	195.96	231.51	239.04	246.17	285.68	292.19

Source: Montana Tax Foundation, 1983-1984 and 1985. Mountain International, Inc., 1984, vol. 1, p. 304.
NA means not available.

July 1975 and July 1984, implicit price deflator for state and local expenditures). Real or inflation-adjusted, per-pupil expenditures in the Gardiner elementary school increased from FY72 to FY76, decreased from FY76 to FY79, and then again increased from FY79 to FY83. Average annual growth in real per-pupil expenditures over that time was 7.1 percent. In spite of such growth, Gardiner elementary per-pupil expenditures are less than those of comparably sized school districts, and less than the statewide average for communities under 500 population ($2,756 per pupil 1982) (Mountain International, Inc., 1984, vol. 1, pp. 317-318).

Revenue and budget conditions for the Gardiner High School district #4 are similar to those for the elementary school district. Payments from the state School Foundation Program have been the major source of general fund revenues (see table II-35). Such revenues accounted for 71 percent of the FY83 budget, up from 51.5 percent in FY72.

The second largest source of revenue is federal PILT for the Mammoth, Wyoming students attending Gardiner High School. These revenues made up 20 percent of FY83 general fund revenues. Without the federal PILT, property tax levies would increase 65.5 mills in order to maintain the same level budget (Mountain International, Inc., 1984, vol. 1, p. 322).

Although nominal per-student expenditures have increased from FY72 to FY83, real (inflation-adjusted) spending has varied. The general trend in real per-pupil spending has been upward. However, in FY74, FY81, and FY83 average per-pupil expenditures fell below the level of the preceding fiscal year (see table II-35). Overall real inflation-adjusted, per-pupil expenditures for Gardiner High School have increased from $2,461 in FY72 to $3,323 in FY83, for an average annual increase of 2.85 percent. Although per-pupil spending has increased, Gardiner high school expenditures remain below those

Table II-34: Budget and Revenue Sources Gardiner Elementary School District #7 FY 1972 to 1983

	General fund revenue[1]				General fund budget per ANB			
Fiscal year	Foundation and permissive payments	Tuition[2]	Federal aid[3]	Other funds[4]	Total general fund budget	ANB[5]	Nominal dollars	1980 dollars
1983	$247,276	$70,000	$30,000	$35,378	$383,104	135	$2,838	$2,378
1982	240,528	62,500	20,500	10,590	334,118	139	2,404	2,089
1981	175,738	60,000	25,000	19,209	279,947	128	2,187	2,013
1980	172,990	40,000	25,000	31,986	269,976	142	1,901	1,901
1979	172,480	40,000	25,907	5,991	244,378	150	1,629	1,794
1978	142,494	40,000	32,491	-0-	214,985	137	1,569	1,884
1977	129,914	44,752	32,500	3,402	209,568	136	1,541	1,980
1976	119,246	52,299	38,000	7,658	217,203	139	1,563	2,124
1975	188,354	50,000	20,000	14,105	202,459	148	1,368	1,936
1974	78,649	36,506	20,000	-0-	135,155	140	965	1,478
1973	60,705	22,000	31,319	17,569	131,593	143	920	1,409
1972	60,281	28,978	27,000	3,848	120,107	146	822	1,117

Sources: Gardiner School District #7, Mountain International, Inc., 1984, vol. p. 317. Survey of Current Business, July issues of 1975, 1977, 1979, 1982, 1984, implicit price deflator for state and local government expenditures.

[1] FY70 was the last year that a district-voted levy was imposed. Since that year, there have been no revenues from a voted levy.

[2] Tuition includes 604 funds paid by National Park Service, categorized as tuition beginning in 1972.

[3] Federal Impact Assistance per Public Law 81-874.

[4] Includes cash reappropriations and state deficiency levy, 604 funds.

[5] ANB (average number belonging) means the average number of regularly enrolled, full-time pupils attending the public schools of a district.

Table II-35: Budget and Revenue Sources, Gardiner High School District #4 FY 1972 to 1983

	General fund revenue[1]					General fund budget per ANB		
Fiscal year	Foundation and permissive payments	Tuition[2]	Federal aid[3]	Other funds[4]	Total general fund budget	ANB[5]	Nominal dollars	1980 dollars
1983	$244,928	$70,000	$30,000	$ -0-	$344,928	87	$3,965	$3,323
1982	198,556	60,000	40,000	22,864	321,420	81	3,968	3,448
1981	169,733	65,000	39,164	9,450	283,347	85	3,333	3,067
1980	152,021	15,000	5,000	96,743	268,764	82	3,278	3,278
1979	140,409	15,083	9,124	63,308	227,924	NA	NA	NA
1978	135,638	40,000	20,000	30,911	226,548	90	2,517	3,022
1977	124,825	65,000	20,904	9,271	220,000	101	2,178	2,799
1976	113,552	48,040	54,000	7,270	222,863	110	2,026	2,754
1975	101,867	40,000	45,000	16,051	202,918	114	1,780	2,519
1974	105,735	36,924	24,971	-0-	167,630	116	1,445	2,213
1973	79,357	35,000	35,728	6,578	156,663	112	1,399	2,374
1972	73,715	-0-	35,000	34,310	143,025	104	1,375	2,461

Sources: Gardiner School District #4; Mountain International, Inc., 1984, vol. p. 317. Survey of Current Business, July issues of 1975, 1977, 1979, 1982, and 1984, implicit price deflator for state and local government expenditures.

[1] FY70 was the last year that a district-voted levy was imposed.

[2] Includes 604 funds (PILT) paid by National Park Service, categorized as tuition beginning in 1972.

[3] Federal Impact Assistance per Public Law 81-874.

[4] Includes cash reappropriations and state deficiency levy, 604 funds.

[5] ANB (average number belonging) means the average number of regularly enrolled, full-time pupils attending the public schools of a district.

NA means not available.

of comparably sized schools, and below the statewide average for communities with fewer than 500 people (Mountain International, Inc., 1984, vol. 1, p. 320).

The total mill levy assessed against Gardiner area property for the support of education in the state and county is shown in table II-36. In FY83, 123.51 mills was levied on property in Gardiner to support education.

The taxable value of property in the Gardiner school districts has not kept pace with inflation (see table II-37). The real value (adjusted for inflation) of taxable property in the elementary school district decreased 43 percent, while property in the high school district decreased 37 percent.

Gardiner Area Special Districts

There are three special districts in the Gardiner area providing fire protection, water supply and distribution, and sewage disposal (Mountain International, Inc., 1984, vol. 1, p. 323). None of the district budgets is large, and the taxable valuation of property within each district is small. District expenditures over the past decade have risen and fallen as capital improvements and equipment acquisitions have been undertaken; however, the general expenditure trend is upward.

Table II-38 shows the budgets of each special district for selected years. The fire and sewer districts are funded largely by property taxes, while the water district relies primarily on user fees.

Real inflation-adjusted expenditures have decreased for all districts from FY70 to FY80. Real revenues for the water and sewer districts also declined between FY75 and FY80. However, value of real-tax revenues received by the fire district increased between FY75 and FY80, and the FY80 revenues totalled more than FY70 revenues.

Fiscal Forecasts

Expenditures for Park County and both Gardiner school districts are expected to rise due to increases in population and the cost of service. Forecasts are based on results formulated by Mountain International, Inc., a consultant to the applicant; however, DSL altered those fiscal projections for Park County to reflect recent adjustments to census population counts for Park County. The assumptions of the forecast include: 1) four expenditure categories increase over the forecast period at the following rates--general government (2.7 percent), public safety (2.94 percent), public services (1.37 percent), and transportation (0.9 percent); 2) all other expenditure categories are assumed to remain constant; 3) existing indebtedness is paid according to schedule and is fully retired in FY93; and 4) no future debt service expenditures are estimated because there are no planned capital facility requirements (Mountain International, Inc., vol. 1, p. 328).

Table II-39 shows the projected total expenditures for Park County from FY1987 to FY2010. Expenditures rise from $2.2 million in FY1987 to $3.5

Table II-36: Property Tax Levies for Education Purposes Imposed on Gardiner Area Property FY83

Levy	Mills
Statewide	
University levy	6.00
County-wide	
General school	25.00
High school general	15.00
Transportation	4.62
Retirement	39.37
Gardiner Elementary District #7	
General (voted levy)	-0-
Transportation	8.30
Insurance	-0-
Bonded indebtedness/sinking fund	14.15
Gardiner High School District #4	
General (voted levy)	-0-
Transportation	11.07
Insurance	-0-
Bonded indebtedness/sinking fund	-0-
TOTAL	123.51

Sources: Montana Tax Foundation. Mountain International, Inc., 1984, vol. 1, p. 12.

Table II-37: Taxable Value of Gardiner School Districts Selected Fiscal Years

Fiscal Year	Gardiner Elementary District #7		Gardiner High School District #4	
	Nominal dollars	1980 dollars	Nominal dollars	1980 dollars
1983	$1,074,558	$900,496	$1,526,309	$1,279,070
1982	1,126,019	978,434	1,578,848	1,371,912
1981	1,133,532	1,043,199	1,575,574	1,450,014
1980	1,073,614	1,073 614	1,489,881	1,489,881
1975	1,054,931	1,492,748	1,324,881	1,874,733
1972	887,883	1,589,311	1,131,306	2,025,038

Sources: Gardiner School Districts #4 and #7. Mountain International, Inc., 1984, vol. 1, p. 315. Survey of Current Business, July issues, 1977, 1979, 1982, and 1984, implicit price deflator for state and local government expenditures.

Table II-38: Gardiner Service District Budgets FY70, 75, and 80

Districts	1970[1]		1975[1]		1980[1]	
	Nominal dollars	1980 dollars	Nominal dollars	1980 dollars	Nominal dollars	1980 dollars
Fire District						
District taxes	$7,721	$14,941	$9,888	$13,992	$16,020	$16,020
Expenditures						
Operating expenditures	4,620	8,940	7,932	11,224	7,534	7,534
Capital outlays	4,591	8,884	727	1,029	2,686	2,686
TOTAL	$9,211	$17,824	$8,659	$12,253	$10,220	$10,220
Water District						
Revenues						
Commercial	NA		$43,715	$61,858	$47,511	$47,511
District taxes[2]	NA		11,573	16,376	677	677
Miscellaneous	NA		1,098	1,554	-0-	-0-
TOTAL	NA		$56,386	$79,788	$48,188	$48,188
Expenditures						
Pumping and distribution	NA		$ 9,161	$12,963	$ 9,390	$ 9,390
Maintenance and operation	NA		3,333	4,716	4,103	4,103
Miscellaneous	NA		4,872	6,894	10,080	10,080
operating expenditures	NA		17,366	24,573	23,573	23,573
Debt service	NA		10,140	14,348	6,943	6,943
TOTAL	NA		$44,872	$63,494	$54,089	$54,089
Sewer District						
Taxable Value	$42,297	$81,850	$145,106	$205,328	$320,926	$320,926
Taxes levied	212	410	24,560	34,753	24,091	24,091

Sources: Gardiner Volunteer Fire District. Gardiner Water District. Gardiner Sewer District. Mountain International, Inc., 1984, vol. 1, p. 324. Survey of Current Business, July issues, 1975, 1977, 1979, 1982, and 1984, implicit price deflator for state and local government expenditures.

[1] Columns may not sum to totals due to rounding.

[2] District taxes were levied from 1974 to 1976, balances after this date are apparently delinquencies.

NA means not available.

million in FY2010, for an annual increase of 2.05 percent. Expenditures would be higher if unforeseen capital projects were to be budgeted.

Table II-40 shows the projected increase in expenditures for the elementary school in Gardiner (district #7). Total expenditures are forecast to rise from $425,869 in FY87 to $807,270 in FY2009. Such expenditures indicate that per-student expenditures will also rise from $3,466 to $5,981.

Table II-41 shows projected expenditures for the Gardiner high school district #4. Total costs are expected to rise almost 66 percent from $334,620 in FY87 to $554,091 in FY2009. Per-student costs increase 53 percent over the forecast period.

Table II-39: Projected Park County Expenditures FY1987 to FY2010 (1980 dollars)

Fiscal year	Debt service[1]	Capital outlays[1]	Operating expenditures	Total
1987	$26,191	$275,412	$1,866,066	$2,167,669
1988	23,665	277,846	1,912,897	2,214,408
1989	21,842	280,280	1,960,979	2,263,101
1990	19,034	282,737	2,010,353	2,312,124
1995	-0-	301,130	2,279,004	2,580,134
2000	-0-	305,011	2,564,080	2,869,091
2005	-0-	312,543	2,890,441	3,209,984
2010	-0-	319,455	3,142,196	3,461,651

[1]Mountain International, Inc., vol. 1, 1984a, p. 138.

Table II-40: Forecasted Expenditures for Gardiner Elementary School District #7, FY1987 to FY2009 (1980 dollars)

Fiscal year	Total expenditures	Debt service	Capital outlays	Operating expenditures	Operating expenditures per student
1987	$425,869	$4,583	$15,738	$405,548	$3,466
1988	435,526	4,138	15,738	415,650	3,553
1989	445,469	3,718	15,738	426,013	3,641
1990	455,701	3,320	15,738	436,643	3,732
1995	535,935	-0-	16,545	519,390	4,223
2000	624,155	-0-	17,083	607,071	4,780
2005	721,219	-0-	17,487	707,733	5,413
2009	807,270	-0-	17,755	789,515	5,981

Source: Mountain International, Inc., vol. 1, 1984a, p. 335.

Table II-41: Forecasted Expenditures for Gardiner High School District #4, FY1987 to FY2009 (1980 dollars)

Fiscal year	Total expenditures[1]	Capital outlays	Operating expenditures	Operating expenditures per student
1987	$334,620	$9,870	$324,750	$4,218
1988	340,620	9,870	331,089	4,300
1989	347,425	9,870	337,555	4,384
1990	354,021	9,870	344,151	4,469
1995	409,259	10,393	398,876	4,924
2000	449,976	10,383	439,593	5,427
2009	554,091	10,767	543,324	6,468

Source: Mountain International, Inc., vol. 1, 1984, p. 337.

[1] The district does not have any outstanding debt.

LAND USE

Land uses on the permit area within a five-mile radius of the project and within Park County are similar. Recreation, farming, ranching, residential development, logging, and mining are typical area land uses.

Development of the proposed project would occur on both public and private land. Most of the permit area is privately owned by Homestake Mining Company; however, tailings would be located on a small amount of Forest Service land. Of the 410-acre permit area, 17 acres of land have been previously disturbed by mining activity.

Recreation is a primary land use in the Gardiner-Jardine area. Yellowstone National Park borders Gardiner to the south. The Absaroka-Beartooth Wilderness lies to the east of Gardiner. Nonwilderness Forest Service lands are to the east, west, and north of Gardiner and Jardine. Fishing, hiking, camping, and picnicking all occur on public lands in the project area (see Recreation). Big game hunting is also a source of recreation--including a regular fall season and a late season in winter.

Residential development is concentrated at Jardine and Gardiner, with some scattered development along the Jardine Road. Ranching is confined to several small properties along Bear Creek near Jardine and Gardiner, and some grazing of domestic livestock, primarily horses, is also present. Mining is limited to panning for gold in Bear Creek and the Yellowstone River, and quarry mining of travertine near Gardiner (project application, 1984, p. 1-H-2).

Logging occurs on public, Forest Service-managed land in the project area. Both commercial harvests and firewood cutting occur. No livestock grazing is allowed on Forest Service lands in the project area (project application, 1984, p. 1-H-1).

Land use within Park County is much the same as the immediate vicinity of the project area. Residential uses are concentrated at existing towns, mainly in Livingston. Small towns north of Livingston (Wilsall and Clyde Park) and south (Emigrant and Corwin Springs) have small amounts of residential development. Otherwise, development is scattered mostly along the Yellowstone and Shields rivers.

Ranching and farming land uses are more prominent in Park County than in the immediate Gardiner area. While the project area has some livestock grazing (primarily horses), the balance of the county produces alfalfa hay, barley, oats, cattle, hogs, sheep, and small amounts of winter and spring wheat (Montana Agricultural Statistics, County Statistics, 1982 and 1983, vol. XX).

Two private entities own large amounts of land in Park County--the Burlington Northern Railroad (BN) and the Church Universal and Triumphant. The Church Universal and Triumphant began purchasing land in 1981 and is the second largest landowner after BN. The church owns over 30,000 acres, most of it agricultural land (Mountain International, Inc., 1984, vol. 1, p. 105).

Projected Trends

Recreation will remain a dominant land use in the Gardiner-Jardine area. The number of users will fluctuate depending on the level of tourism in Yellowstone National Park, and Montana in general. Fall and winter recreational use will be influenced by hunting regulations determined by the Montana Department of Fish, Wildlife and Parks (see Wildlife).

There will be some conversion of agricultural land to residential development due to population growth. However, the amount of such development will be small.

Farming and ranching will continue in the area. The number of acres in production may decline, if agricultural profitability continues at its present low.

TRANSPORTATION

Park County contains 143 miles of interstate and primary highways, 51 miles of secondary roadways, 846 miles of local roads, and 13 miles of urban streets and roads (Mountain International, Inc., 1984, vol. 1, p. 230). The major roads in Park County are Interstate 90, which runs east and west, and U.S. Highway 89 (also numbered Federal Aid Primary [FAP] 11), which runs north and south (see figure II-27, Chapter II--Recreation).

U.S. 89

U.S. Highway 89 connects Livingston, Gardiner, and Yellowstone National Park. The condition of U.S. 89 was surveyed by the Montana Department of Highways (MDOH) in 1983 and received 74.2 out of a possible 100-point score

for factors such as safety, drainage, and surface sufficiency. All but one section of U.S. 89 received a maximum score of 10 for drainage sufficiency. Safety ratings were high in 6 of 10 sections. Safety-deficient sections are at the Yellowstone National Park boundary (mile post 0), north of Corwin Springs (mile posts 10.8 to 16.6), near the southern junction of U.S. 89 and Federal Aid Secondary (FAS) 540 (mile posts 19.3 to 30.9), and north of Emigrant (mile post 40.7 to 51.8) (MDOH, 1983, p. 35). Capacity ratings were generally 20 or better out of a possible-30 score, with the lowest capacity rating of 18 at the park boundary. Surface stability ratings were 21 points or greater (out of a possible 30) for all sections of U.S. 89 except the section north of Emigrant (mile posts 40.7 to 49.9), which received a 17. A nine-mile section of U.S. 89 directly south of the northern junction with FAS 540 was rated as deficient (MDOH Sufficiency Ratings, 1983, pp. 107 and 109).

Table II-42 lists the average daily traffic (ADT) measured at three locations on U.S. 89 near Gardiner between 1970 and 1983. The highest and most consistent rates of growth in ADT occurred at the border of Yellowstone National Park. Between 1970 to 1984, ADT at that location increased at an annual rate of 7 percent. The 10-year rate of change was 9 percent and ADT increased at an annual rate of 15 percent over the most recent five years.

Traffic counts on U.S. 89 taken at the northern edge of Gardiner showed smaller increases over the same time period. Traffic counts grew at average annual rates of 3 percent between 1970 and 1984; 4 percent over the last 10 years; and 7 percent over the last five years (see table II-42).

A permanent traffic counter 20 miles north of Gardiner near the southern junction of U.S. 89 and FAS 540 records counts 24 hours each day, year round. Recorded ADT at this location increased 2.4 percent between 1970 and 1983, and 1.7 percent between 1979 and 1983. Over the last five years, ADT has decreased from a peak of 1,186 vehicles per day in 1979 to 960 vehicles per day in 1983, for an average annual decline of 4.3 percent. However, ADT at the southern U.S. 89-FAS 540 junction increased from 880 in 1982 to 960 vehicles per day in 1983, possibly signaling renewed long-term traffic increases.

Accident rates and traffic accident fatality rates for U.S. 89 between Gardiner and Livingston are below those for the state as a whole (see table II-43). The statewide accident rate per million vehicle miles driven is 2.67 for secondary roads (Willard Butzlaff, Supervisor, Project Planning Section, MDOH, pers. comm., May 29, 1985). The section of U.S. 89 between Livingston and Gardiner has an accident rate of 2.5 accidents per million vehicle miles driven, slightly lower than the statewide rate.

From 1972 to 1982, there was an average of 42 accidents yearly on U.S. 89 south of Livingston. During the same time period, nine traffic-related fatalities occurred on that stretch of road.

Jardine Road

A two-lane gravel surface road 4.6 miles long, called the Jardine Road, connects Gardiner and Jardine. The Jardine Road provides access to scattered

Table II-42: Average Daily Traffic for Selected Locations on U.S. 89

Year	Yellowstone National Park boundary[1]	Gardiner outskirts[2]	Junction U.S. 89 and FAS 540[3]
1983	3,025	1,155	960
1982	2,400	1,114	880
1981	2,510	1,125	950
1980	1,730	847	920
1979	1,493	819	1,186
1978	1,717	1,007	893
1977	1,639	907	885
1976	1,267	846	813
1975	1,317	919	854
1974	990	727	764
1973	1,086	730	798
1970	1,150	679	691
1970-1984 Annual rate of change	7.015%	3.087%	2.38%
1973-1984 Annual rate of change	9.076%	4.026%	1.69%
1979-1984 Annual rate of change	15.170%	7.120%	(-4.31%)

Source: MDOH, Traffic By Sections, 1970, 1973, 1975, 1976, 1979, 1981, and 1983.

[1]The traffic counter is located at mile post 0.00 at the border of Yellowstone National Park.

[2]The traffic counter is located at mile post 0.787 near the outskirts of Gardiner.

[3]The traffic counter is located at mile post 19.731 near the southern junction of U.S. 89 and FAS 540. This counter is a permanent station which records traffic flows 24 hours per day, year round.

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residences, is used by summer recreationists and by hunters in the fall, and also provides access to the project site. The first mile of the road has steep grades and switchbacks up Z-Hill above Gardiner. The road then traverses high, open benchland before traveling through Bear Gulch, where the road has a steep southside embankment (Mountain International, 1984, vol. 1, p. 238).

A study was undertaken in 1982 to identify high-hazard road locations in Park County. Of the six locations identified, two were on the Jardine Road (Peccia and Associates, Inc., Park County High Hazard Site Locations, 1983, p. 1).

Table II-43: Comparison of Accident Rates for U.S. 89 Between Livingston and Gardiner and Statewide Averages

Year	All accidents		Rate for 100,000 population		Fatal accidents		Rate for 100,000 population	
	U.S. 89	Statewide	U.S. 89	Statewide	U.S. 89	Statewide	U.S. 89	Statewide
1982	46	19,382	359.4	2,409.2	2	215	15.6	26.7
1981	59	21,310	460.9	2,694.1	1	289	7.8	36.5
1980	57	21,359	450.2	2,715.1	2	276	15.8	35.1
1979	47	22,474	350.8	2,859.3	1	275	7.5	35.0
1978	58	24,138	446.2	3,074.9	0	234	0.0	29.8
1977	61	21,705	488.0	3,852.2	0	261	0.0	34.3
1976	39	19,737	309.5	2,621.1	1	249	7.9	33.1
1975	31	18,738	258.3	2,505.1	0	248	0.0	33.2
1974	33	15,760	277.3	2,144.2	0	247	0.0	33.6
1973	29	15,788	245.8	2,189.7	1	273	8.5	37.9
1972	42	16,262	355.9	2,261.8	1	313	8.5	43.5

Source: Mountain International, 1984, vol. 1, pp. 236-237.

The first site is 0.3 miles northeast of U.S. 89 in Gardiner and consists of a hairpin curve through a new residential section. In addition to steep grades through the curve, visibility is limited to 100 feet in several locations (Peccia and Associates, Inc., 1983, p. 31).

The second high-hazard site on the Jardine Road is a 4.3-mile section extending from the switchbacks at Gardiner to the edge of Jardine. Sight distance is restricted to less than 100 feet in several locations due to road grades and curves. Extremely steep side slopes are another hazard of the upper Jardine road (Peccia and Associates, Inc., 1983, p. 34).

On October 25, 1982, a 24-hour traffic count was made on the Jardine Road. A total of 256 vehicles was recorded during that time. An ADT of 233 was calculated by applying factors used by MDOH which reflect statewide traffic patterns that vary according to season and day of the week (Robert Peccia, pers. comm., May 23, 1985). The estimated ADT of 233 for the Jardine Road may be too high; its reliability cannot be verified. The counter was placed on the upper Jardine Road and the count was taken one day after the opening of the deer and elk hunting season, so it would reflect high recreational use which may not be typical of general traffic conditions on the road. The method used to calculate the ADT for the Jardine Road was developed by MDOH for roads in the state which are more typical of traffic patterns on roads similar to U.S. 89 than those on roads which receive sporadic, heavy recreation use. For example, a permanent counter near Hungry Horse Dam recorded a fluctuation in average daily traffic from 817 vehicles in July 1984 to a low of 23 ADT in December, or a range of 3,552 percent. The annual ADT at Hungry Horse was 272 in 1984 (MDOH, Automatic Counters, 1984, Station A-45). By comparison, the fluctuation in average daily traffic measured at the permanent

counter on U.S. 89 varied from a peak ADT of 2,098 in July, 1984 to a low of 500 ADT in December, or a range of 420 percent (MDOH, Automatic Counters, 1984, Station A-20). The annual ADT was calculated at 1,012 for 1984.

Between 1979 and 1982, four accidents were reported on the lower Jardine Road and five were reported on the upper section (Peccia and Associates, Inc., 1983, pp. 31 and 34). All of the accidents on the lower section resulted in injuries. There was one fatality and one injury in the accidents that occurred on the upper section. Four of the five accidents involved vehicles rolling down the steep embankment.

Future Traffic Conditions on U.S. 89

Table II-44 presents forecasted traffic increases for U.S. 89 between Gardiner and Livingston without the Jardine Joint Venture project. These forecasts are based on accident, traffic, and fatality rates between 1972 and 1982. Data for changes on the Jardine Road were not available.

Average daily traffic on U.S. 89 is expected to increase from 1,006 vehicles per day in 1985 to 1,811 ADT in 2010. Over that period, a total of 30 fatalities may occur as a result of accidents. Between 1,746 to 1,898 traffic accidents are expected to occur over the forecast period.

RECREATION

Natural Resources

The primary recreational resources of the project area include Yellowstone National Park, the Gallatin National Forest, and the Yellowstone River and its tributaries. Recreational opportunities exist at both developed and undeveloped sites throughout the county. Figure II-27 identifies the boundaries of the Gallatin National Forest in Park County, Yellowstone National Park (YNP), the Yellowstone River, and a series of campgrounds and public fishing access sites developed to enhance use of the resource base. Several trails wind throughout the study area (figure II-26).

Park County contains several public campgrounds operated by the U.S. Forest Service. Three campgrounds are near Cooke City. Other campgrounds are near the Gallatin County border in Tom Miner Basin, Emigrant Gulch, near the Pine Creek Bridge along the Yellowstone River in the northern portion of the Paradise Valley, and along the county's eastern border; all are accessible through Sweet Grass County.

The Montana Department of Fish, Wildlife and Parks maintains 16 fishing access sites in the county, starting with the Queen-of-the-Waters and Corwin Springs sites near Gardiner. The remaining 14 sites are stretched out along the Yellowstone River to Springdale on the county's eastern border (figure II-27). The National Park Service and TWA Services, Inc., provide campgrounds, lodging and meal services, interpretive trails, and other visitor services throughout the park.

Table II-44: Projected Traffic and Accident Rates for U.S. 89 Between Livingston and Gardiner

Year	Average daily traffic[1]	Total annual mileage (millions)	Low accident rate[2]	High accident rate[3]	Fatalities[2]
1985	1,006	19.02	47	51	1
1990	1,132	21.40	53	57	1
1995	1,273	24.07	59	64	1
2000	1,432	27.07	67	72	1
2005	1,611	30.46	75	81	1
2010	1,811	34.26	84	91	1
TOTAL[4]	N/A	710.68	1,746	1,898	30

[1] Traffic is assumed to increase on U.S. 89 between Gardiner and Livingston at the historic (15-year) rate as measured at the permanent traffic counter located near the southern junction of U.S. 89 and FAS 540. Traffic count estimates are based on the 1983 reading of 960 vehicles per day at the permanent traffic counter.

[2] Accident and fatality estimates for U.S. 89 were developed by the Department of State Lands. The accident rate was calculated to be 2.457 accidents per million vehicles miles driven. The fatality rate was calculated to be 4.27 fatalities per one hundred million vehicle miles driven. Total annual miles driven was calculated by multiplying average daily traffic counts times the segment length (51.8 miles) times 365 days per year. Each year from 1972 to 1982 was summed and the total was divided by one million to arrive at an adjusted total mileage. The total number of accidents which occurred from 1972 to 1982 was then divided by the adjusted total mileage to determine the number of accidents per million vehicle miles driven. The number of fatalities was expressed as a number of fatalities per one hundred million vehicle miles driven. The total number of fatalities was divided by the total adjusted mileage and then multiplied by 100.

[3] The statewide accident rate per million vehicle miles driven is 2.67 for secondary roads over the period 1977-1984 (Willard Butzloff, Supervisor, Project Planning Section, MDOH, per. comm., May 29, 1985).

[4] Totals will be greater than the sum of each forecast point, because totals reflect each annual change which is not listed in the table.
N/A means not applicable.

Major recreation activities throughout the project area include hunting, fishing, hiking, horseback riding, wilderness camping, some snowmobiling, and antler collecting (see table II-46). This last activity is illegal in Yellowstone National Park.

Visitation

Table II-45 summarizes visitor counts conducted at 8 of the county's 15 fishing access sites. The greatest volume of use takes place at Daily Lake in

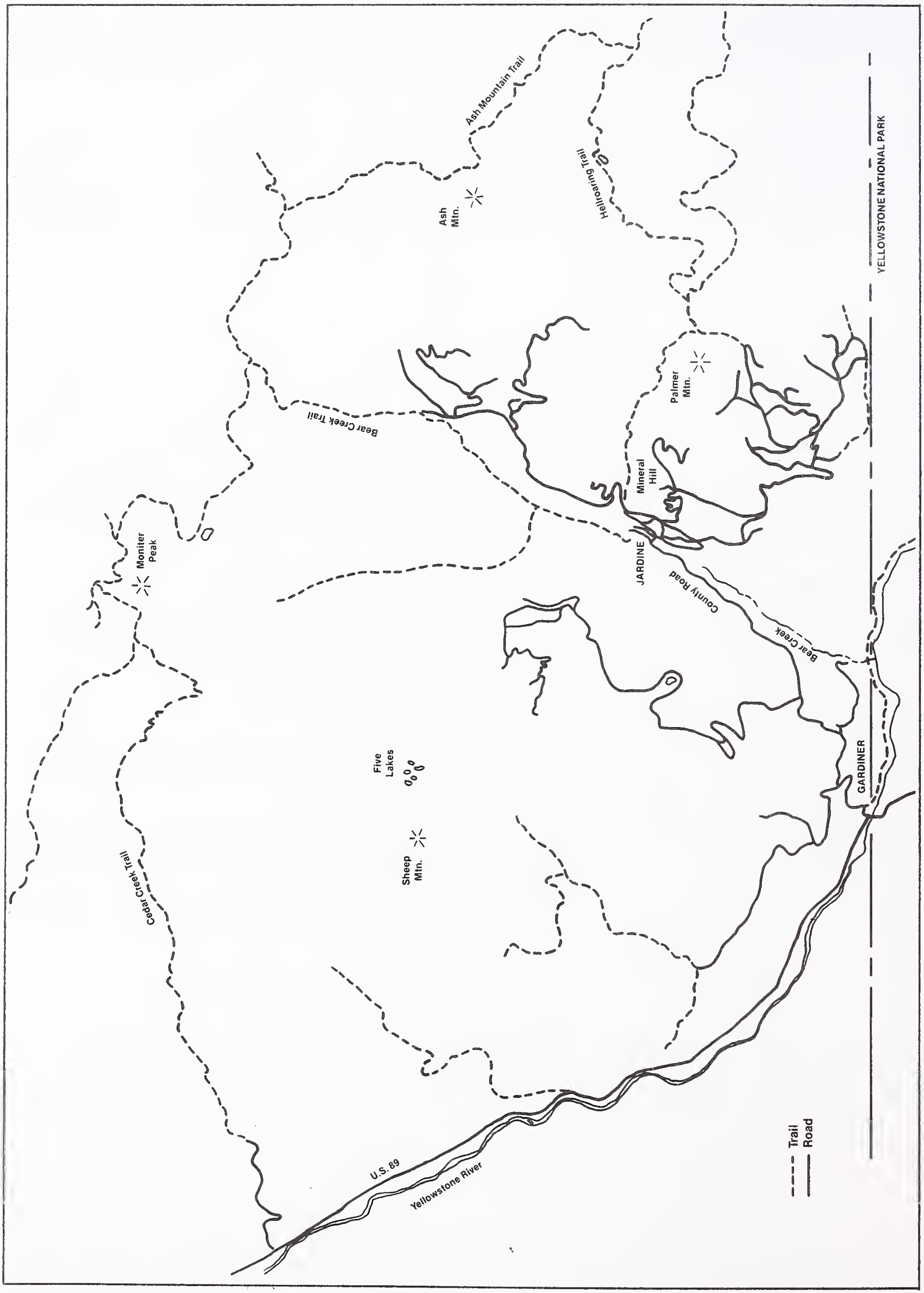

Figure II-26: Several Forest Service-maintained trails and roads wind throughout the study area.

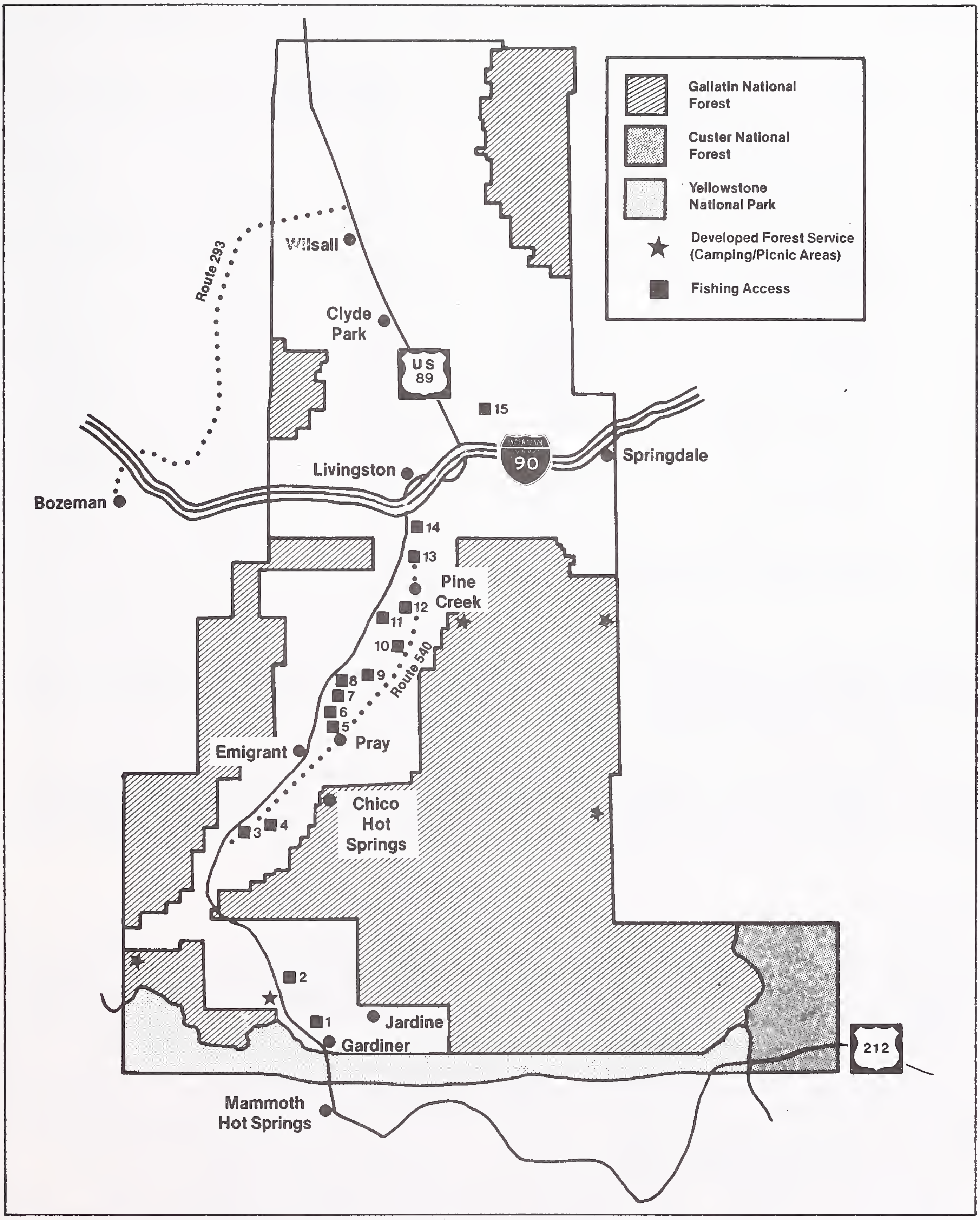

Figure II-27: Fifteen fishing access sites are maintained by the Montana Department of Fish, Wildlife and Parks. The U.S. Forest Service maintains developed camping and picnic areas in the Gallatin National Forest. These fishing access sites primarily line U.S. 89.

Table II-45: Visitor Use of Park County Fishing Access Sites, 1980-1983 (see figure II-27 for location)

No.	Site	1980	1981	1982	1983
1	Queen-of-the-Waters	800	900	900	1,000
2	Corwin Springs	no count	no count	no count	2,400
3	Point of Rocks	no count	no count	no count	no count
4	Daily Lake	19,300	18,800	23,000	no count
5	Emigrant	3,300	3,700	3,800	no count
6	Emigrant North	no count	no count	no count	1,000
7	Grey Owl	no count	no count	no count	no count
8	Chicory	no count	no count	no count	800
9	Paradise	no count	no count	no count	4,000
10	Loch Laven	4,100	4,100	3,900	no count
11	Mallard's Rest	6,500	14,000	14,900	16,200
12	Pine Creek Bridge	no count	no count	no count	10,200
13	Carter's Bridge	4,100	21,600	23,000	no count
14	Free River	no count	no count	no count	3,800
15	Sheep Mountain	3,300	3,100	4,100	3,300
16	Springdale Bridge	3,300	4,500	4,400	4,500

Source: Montana Department of Fish, Wildlife and Parks (1983).

the Paradise Valley and at Carter's Bridge on the outskirts of Livingston. In general, visitors are more frequent at sites in the northern Paradise Valley near Livingston than at locations near Gardiner.

Little information exists about fishing pressure on Bear Creek. The Montana Department of Fish, Wildlife and Parks estimates that 919 man days of fishing pressure occurred during the period April 1, 1982 through March 31, 1983 (Bob McFarland, pers. comm., March 13, 1985).

Organized Recreation

Outside the immediate Livingston area there is relatively little organized recreation. Gardiner has an informal softball league that participates in the Yellowstone Park Recreation Program softball series. There is no Little League or similar organization for Gardiner's youth.

Interscholastic high school sports provide a recreational outlet for the area's youth during the school year. The area's adults are reportedly very active supporters of the school's athletic program and have organized a Gardiner High School booster club.

The only formally organized recreational program in the area is the Yellowstone Park Recreation Program, located in Mammoth, Wyoming. This program, funded by the National Park Servie and park concessionaires, is for park employees. It organizes discount-rate, white-water raft trips, movies,

Table II-46: Human Activity in the Jardine Wildlife Study Area, 1981-1982

Category	Number of observations	Percent of observations	Remarks
Cross-county skiiing	4	1.3	
U.S. Forest Service employees	5	1.4	Includes weed spraying, tree planting, trail maintenance, other FS activities
Horse packing	7	1.9	Does not include hunters
Hiking/fishing	9	2.5	Does not include hunters
Firewood/logging	11	3.2	
Recreation driving/ sightseeing	14	3.8	
Camping	38	10.8	Does not include hunters
Antler collecting	63	17.8	
Hunting	205	57.3	Bow hunting, gun hunting, camping, horse packing and associated activities
	356	100.0	

Source: Westech, 1984.

The only formally organized recreational program in the area is the Yellowstone Park Recreation Program, located in Mammoth, Wyoming. This program, funded by the National Park Service and park concessionaires, is for park employees. It organizes discount-rate, white-water raft trips, movies, dances, various team sports, and classes in dance, arts and crafts, exercise, sports, and the like. Although the program is organized for park employees, some Gardiner area residents who do not work in Yellowstone participate in basketball, volleyball, and softball programs. Gardiner school playing fields are available for some events.

Finally, a small alpine ski hill is available in the Mammoth area; Gardiner school children use this resource one day a week. Scouting units for boys and girls also have been organized in the area.

One theater, which operates in the summer, and a number of taverns (see Commercial Services) also serve as recreational outlets in Gardiner. The Chico Hot Springs Lodge, providing food, drink, lodging, swimming, hot tubs, and a hot pool, is located about 33 miles north of Gardiner, off U.S. Highway 89.

National Forest

The closest developed national forest campground is in Tom Miner Basin--about 30 miles by road from the project site. This campground is seldom used to its 12-family-unit capacity. There is a roadside picnic ground--a rest stop at LaDuke Springs about 10 road miles northwest of the project area. There are also several minimum-development occupancy sites within 10 to 20 miles of the project area including Eagle Creek and Yankee Jim Brown. These sites have minimum facilities--usually just a few parking spaces, a toilet, and a few fire rings.

A portion of the Yellowstone River flows through scattered national forest tracts between Yellowstone Park and Yankee Jim Canyon. This stretch of the river experiences moderate fishing pressure. Outfitters provide floating and fishing service in addition to moderate public floating use.

There are four access points to the Absaroka-Beartooth Wilderness in the project area: Palmer, Pine Creek, Knox Lake, and the North Fork Bear Creek trailheads. In addition, several outfitters permitted on the Gardiner district operate all summer and fall on trails into the Absaroka-Beartooth Wilderness from the Jardine area.

There is a large occupancy site up Bear Creek beyond Jardine, which is used occasionally by large, organized groups for camping. A small, undeveloped occupancy site near Knox Lake trailhead is used summer and fall for camping.

The Draft Gallatin Forest Plan projects recreation trends in the next decade as noted below.

--Developed recreation (camp, picnic grounds) up 15 percent,
--dispersed recreation (non-wilderness) up 22 percent, and
--wilderness recreation up 14 percent.

This estimate is appropriate for the national forest surrounding the project area.

CULTURAL RESOURCES

An intensive cultural resource inventory covering about 3,100 acres of private and USDA Forest Service lands in Park County was conducted during 1981-1982 (project application, 1984). One of the primary objectives of the survey was to locate sites included on or potentially eligible for inclusion on the National Register of Historic Places (NRHP).

Six cultural resources sites--two archaeological and four historic--were identified during the surveys. One archaeological and two historic sites are considered eligible for listing on NRHP.

Both archaeological sites are located on terraces near the confluence of Bear and Palmer Creeks. Site 24 PA340 is small (14,000 square feet) with little cultural material. Fewer than 50 fragments, predominantly obsidian, were found. Subsurface testing encountered no intact cultural levels. The site appears to have been a short-term lithic workshop and possible hunting observation area. The site is ineligible for the NRHP.

The second archaeological site (24PA159) is larger (58,000 square feet) and located just south of Palmer Creek. Several hundred pieces of obsidian, chert, and agate were found, including an apparent Late Middle Prehistoric Period or Pelican Lake corner-notched projectile point, an obsidian biface fragment, and a quartzite spall chopper-scraper. In addition, plowing reportedly exposed rock-filled hearths. Four test pits yielded cultural material, including charcoal to a depth of two feet. The site appears to be a campground which may have been reused. The site warrants a recommendation of eligibility on the NRHP.

Of the four historic sites, two are considered eligible for the NRHP. The major site (24PA339) is the Jardine, Montana, Noncontiguous Historic District (figure II-28). Historic Research Associates (HRA) recommended that 49 of the 165 historic structures and features (table II-47) be included in the historic district (project application, 1984). These structures include most of the extant buildings constructed during the late 1890s and early 1900s, the first period of significant mining activity in Bear Gulch. These structures include the Revenue Mill (Structure 34) and several associated structures (Structures 36, 37, 41, 43, 53, 54), the mine office (Structure 73), the guest house (Structure 67), and the schoolhouse (Structure 79). Also represented are a number of structures built shortly after the Jardine Mining Company reopened the mining and milling operations in the early 1920s. These structures include the arsenic mill (Structure 59) and a number of residential dwellings. It was during the period from 1920 to 1948 that Jardine gained prominence as a nationwide leader in the production of commercial arsenic and tungsten.

In addition to the structures and features described above, there are two structures and one feature located outside the immediate vicinity of Jardine that should be included as noncontiguous portions of the historic district. These include the Stuart-Schultz Cabins (24PA410, Feature 164), the George Welcome-Harry C. Bacorn residence (Structure 103), and the Jardine water supply system. Dr. James Stuart, the assayer for the Bear Gulch Mining Company, was an important individual in the early development of Jardine. George Welcome, who arrived in Jardine in the 1890s, was associated with Harry Bush in the Bear Gulch Mercantile and Land Company. He also operated a hotel and general merchandise store in Jardine. His house (Structure 103) was built in the early 1900s and was later occupied by Harry C. Bacorn. Bacorn was the manager of the Jardine Mining Company in the early 1920s and was instrumental in the mining revival that characterized Jardine in that decade. The Jardine water supply system, which consists of a dam, pond, and wooden flume (Feature 163), was constructed in 1903; it was designed to supply water for the mills and

Figure II-28: Historical Research Associates recommended that 49 of the 165 historic structures and features in Jardine be included in the historic district.

Table II-47: Jardine Historic District Structures and Features

Number	Type of Structure	Condition	Significant	Contributes	Neutral	Intrusive
S.34	Revenue stamp mill	Poor	X			
S.35	Wood and concrete foundation	Very poor		X		
S.36	Frame water storage building	Poor	X			
S.37	Frame building (ore station)	Poor	X			
S.38	Ore car	Good		X		
S.39	Frame and concrete powerhouse	Good		X		
S.40	Frame tram control house	Fair		X		
S.41	Frame compressor house	Poor	X			
S.42	Squared timbers-mine portal	Very poor		X		
S.43	Frame blacksmith shop	Poor	X			
S.44	Squared timbers-mine portal	Very poor		X		
S.45	Frame outhouse	Very poor		X		
S.46	Frame shack	Poor		X		
S.47	Frame shack	Poor		X		
S.48	Wooden trestle	Very poor		X		
S.49	Frame and metal office	Very poor		X		
S.50	Frame "dry house"	Very poor		X		
S.51	Wooden fly wheels	Poor		X		
S.52	Wooden sluice box	Poor		X		
S.53	Several frame structures	Poor		X		
S.54	Frame electric substation	Poor	X			
S.55	Stone and metal "oven"	Very poor		X		
S.56	Frame shed	Fair		X		
S.57	Metal machinery/parts	Very poor		X		
S.58	Frame assay office	Poor		X		
S.59	Frame and bean "arsenic plant"	Poor	X			
S.60	Concrete and metal "refining furnace"	Very poor		X		
S.61	Wooden "cyanide vats"	Very poor		X		
S.62	Frame and metal garage	Fair		X		
S.63	Log house	Fair		X		
S.64	Log house	Poor		X		
S.65	Log house, wooden shake ext.	Poor		X		
S.67	Frame "guest house"	Good	X			
S.68	Mobile home	Good				X
S.69	Stone fireplace	Good			X	
S.70	Log "bunkhouse"	Fair		X		
S.71	Two log cabins	Good		X		
S.72	Wooden bridge	Good			X	
S.73	Frame "mine office"	Good	X			
S.74	Frame house	Excellent			X	
S.75	Frame house	Excellent			X	
S.76	Frame house	Excellent			X	
S.77	Frame house	Excellent			X	
S.78	Frame house	Excellent				X
S.79	Frame schoolhouse	Good	X			
S.103	Frame house	Good	X			
S.163	Frame house (24PA410)	Good	X			
F.164	Water supply system	Poor	X			

residences in Jardine. The above structures and features are essential parts of the Jardine Historic District and should be included as noncontiguous portions.

The buildings included in the proposed historic district thus represent two significant periods in the history of mining and milling development in the West (1890-1900, 1920-1948). The industrial and residential buildings included in the proposed Jardine Historic District potentially contain information about changes in mining and milling technology and changes in construction techniques that occurred between 1900 and the 1920s. Also, the arsenic mill represents a technological as well as an economical innovation in national mining history that occurred in the late 1910s when arsenic, once considered a by-product of the milling operation, became an economically attractive product. Finally, the structures within the proposed historic district are closely associated with prominent individuals instrumental to local and regional economic development.

HRA recommends that 116 structures and features located in or near Jardine be excluded from consideration as part of the proposed historic district for several reasons. Many of the structures (Structures 80-101) are located in an area that was formerly the commercial center of Jardine. The majority of commercial buildings, constructed during the later 1890s and early 1900s, were dismantled, removed or burned after the United States government sold the town in 1964. This concentration of buildings has therefore lost the most important element that would have qualified it for consideration as part of the historic district. Structures 84-86 are modern mobile homes--nonconforming structures that detract from the integrity of the other buildings. Many older structures are the badly deteriorated remains of shed or barns. It has not been possible to determine the dates of construction or ownership.

Structures 1-33, located on the west side of Bear Creek, include a number of badly deteriorated vertical plank sheds and log structures, several log dwellings in relatively good condition, a modern log home (Structure 8), a mobile home, and a cinder block building. Before the 1960s, land along the west bank of Bear Creek contained numerous log dwellings constructed in the early 1900s by the Bear Gulch Mining Company for its employees. Most of these structures were torn down, moved, or burned in the 1960s. Several structures in this area are probably remnants of these buildings, but they are generally in poor condition or have partially collapsed. A number of structures in this area, built after 1940, do not represent the development of the community between the late 1890s and the 1930s. Also, several of the structures (including the mobile home and cinder block building) are nonconforming structures that are an intrusive element.

Structures and features 104-162 consist of two mill tailings ponds, a number of collapsed mine adits and prospect holes, waste dumps, wooden ore chutes, and portions of a deteriorated trestle. Most of the structures and features are located in Mineral Hill, east of Jardine. Although associated with mining activity in Jardine, the mine adits and related structures are in extremely poor condition. They are generally inaccessible, thus do not contribute to a better understanding of the mining operation.

There are no individuals buried in the Jardine cemetery (Feature 165) that are of "transcendent importance"; the cemetery is not extremely old (the oldest headstone dates to 1899) and contains no distinctive design features.

The Jardine Historic District (24PA339) is described as follows:

> Beginning at the southeast corner of Structure 79 (figure II-28) and proceeding directly northeast to the southeast corner of Structure 45. From the southeast corner of Structure 45 proceeding northeast to the southeast corner of Structure 37, then north to a point directly east of the northeast corner of the northernmost foundation that comprises Structure 35. From this point, the boundary proceeds west to a point directly north of the northwest corner of Structure 34, then proceeds southwest to a point located on the east bank of Bear Creek, directly west of the northwest corner of Structure 59. The boundary then follows Bear Creek to the west side of Structure 72. From the west side of Structure 72, the boundary runs southeast to the southwest corner of Structure 73, then follows the south wall of Structure 73 and proceeds to the point of beginning at the southeast corner of Structure 79.

The noncontiguous portions of the Jardine Historic District include only the immediate area around Structures 103 and 163 (24PA410) and Feature 164.

Site 24PA185 (Mineral Hill Cabins) and Site 24PA342 (Hanlon Hill adits) are recommended as not eligible for listing on the NRHP. Only portions of the Mineral Hill Cabins' walls remain intact and are not an integral part of the Jardine townsite. The adits and shafts at Hanlon Hills are collapsed and no structures are located on the site.

AESTHETICS

The region surrounding the proposed permit area is primarily mountainous, characterized by steep slopes and deep entrenchment of active streams. The area is typified to the west by rolling upland benches that fall steeply to the drainage bottoms.

The proposed permit area includes part of the steep, forested mountain (Mineral Hill) above the town of Jardine. The proposed tailings area is a relatively level bench about 250 feet above Bear Creek.

The aspect of the permit area is generally north and west. Douglas-fir vegetation types dominate on the lower forested elevations. The tailings area is vegetated with an open-sagebrush type mixed with Douglas-fir.

Evidence of man's activities are present throughout the proposed permit area. Abandoned buildings, waste dumps, tailings ponds, exploration trails, and clear cuts and logging areas are common. A few individuals live in the town of Jardine year round. Present human activities include firewood cutting, gardening, livestock use, vehicle traffic, hunting, and fishing.

The permit area is visible in the distance from the northern region of Yellowstone, especially the area around Mammoth, including the scenic walk through Mammoth Terraces. The visibility of the permit area from the Absaroka-Beartooth Wilderness is limited.

Sound levels in the Jardine area have not been measured. The population is small and no major noise sources are present; therefore, the average noise level is probably similar to other small towns--about 45 decibels dB(a) [Elred, 1974]. Intermittent loud sounds from mine exploration, traffic, light aircraft, farm equipment, chain saws, and firearm discharge are probably the major sources of noise. Some local residents have been disturbed by the noise from a compressor at the exploration activities (project scoping meeting November 14, 1984). Natural sound sources would include Bear Creek, wind, rain, thunder, and wildlife.

CHAPTER III: IMPACTS OF THE PROPOSED PROJECT

GEOLOGY

Summary: The tailings dump would be very stable during the operation of the mine and for centuries to follow. Excessive erosion and gullying could occur in the diversion ditch alongside the tailings dump during a 100-year flood event.

Geomorphic Stability

The terrace on which the Jardine Joint Venture proposes to place tailings (see figure III-1) would be stable during operation of the mine and for centuries to follow. Occasional slump failures along the steep slopes adjacent to Bear Creek would occur as a consequence of natural erosional processes, but would not endanger the tailings dump; three relatively recent natural slumps have fallen into Bear Creek (see Chapter II--Geology, Surficial Deposits of Bear Creek).

The diversion ditch along the southeastern edge of the tailings dump (see figure III-2) would be subject to erosion during heavy runoff events. The applicant proposes to line the upper section of the diversion channel with grass. This segment would have an average slope of 5 to 10 percent. Flow velocities much greater than a 100-year event could initiate gully erosion (Haan and Barfield, 1979, p. 136). On the steeper section (22 percent slope) near the downstream end of the dump, the applicant would line the channel with mine waste rock (riprap) averaging 18 inches in size. The riprap, however, would not be stable under the 100-year flood event (U.S. Environmental Protection Agency, 1976, p. 46); flow velocities during such an event would wash away the riprap and lead to gully erosion.

The applicant's reclamation plan would control sheet and rill erosion off the tailings dump slopes. Soil loss due to erosional processes would be low--probably less than five tons/acre/year. Vegetation covering the dump would prevent excessive erosion. Protective layers of pebbles would develop over time from the coarse-textured soils, and would cover the reclaimed slopes and also help reduce erosion (Megahan, 1974).

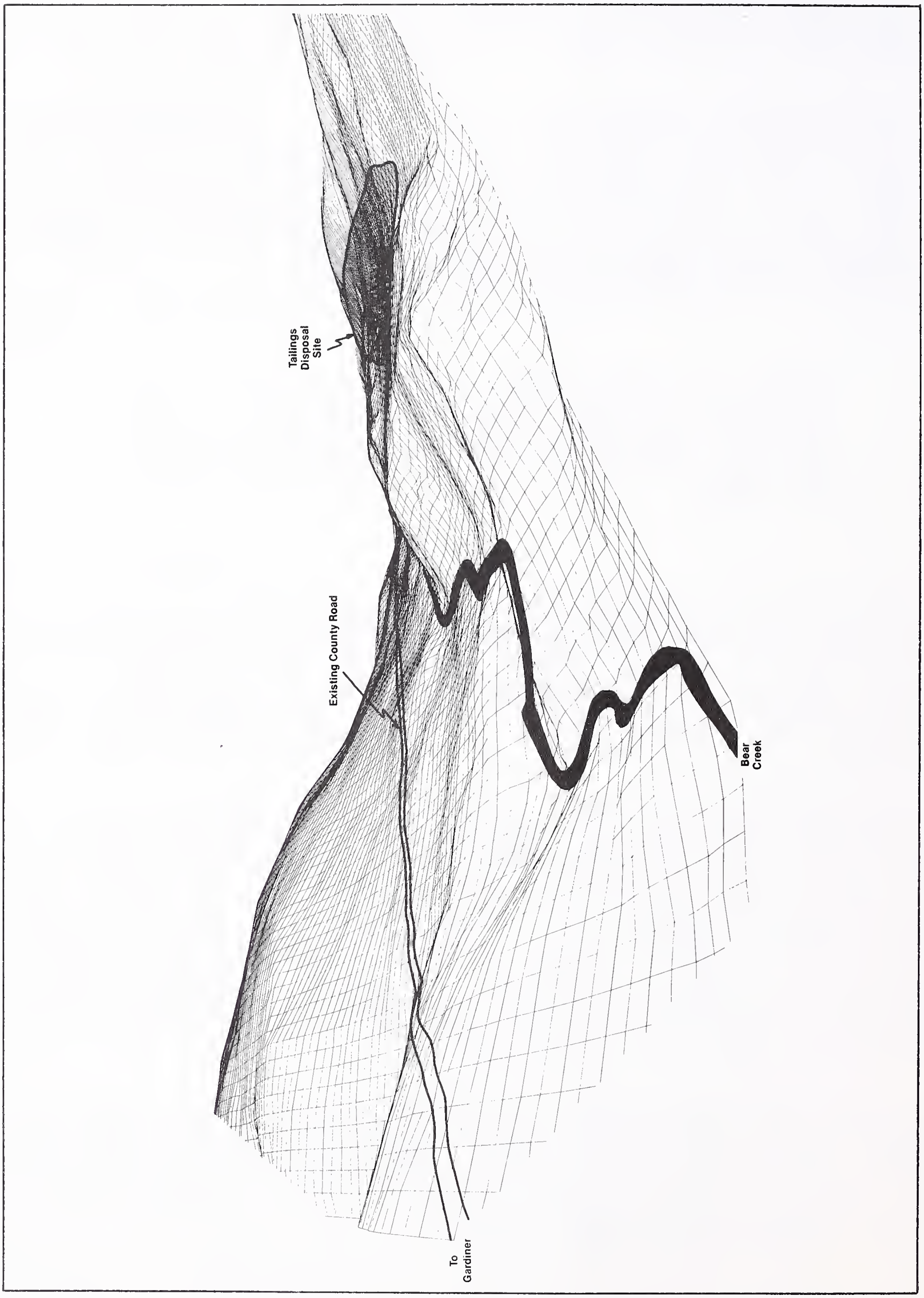

Figure III-1: The proposed tailings dump site is superimposed on this computergraphic of the project area.

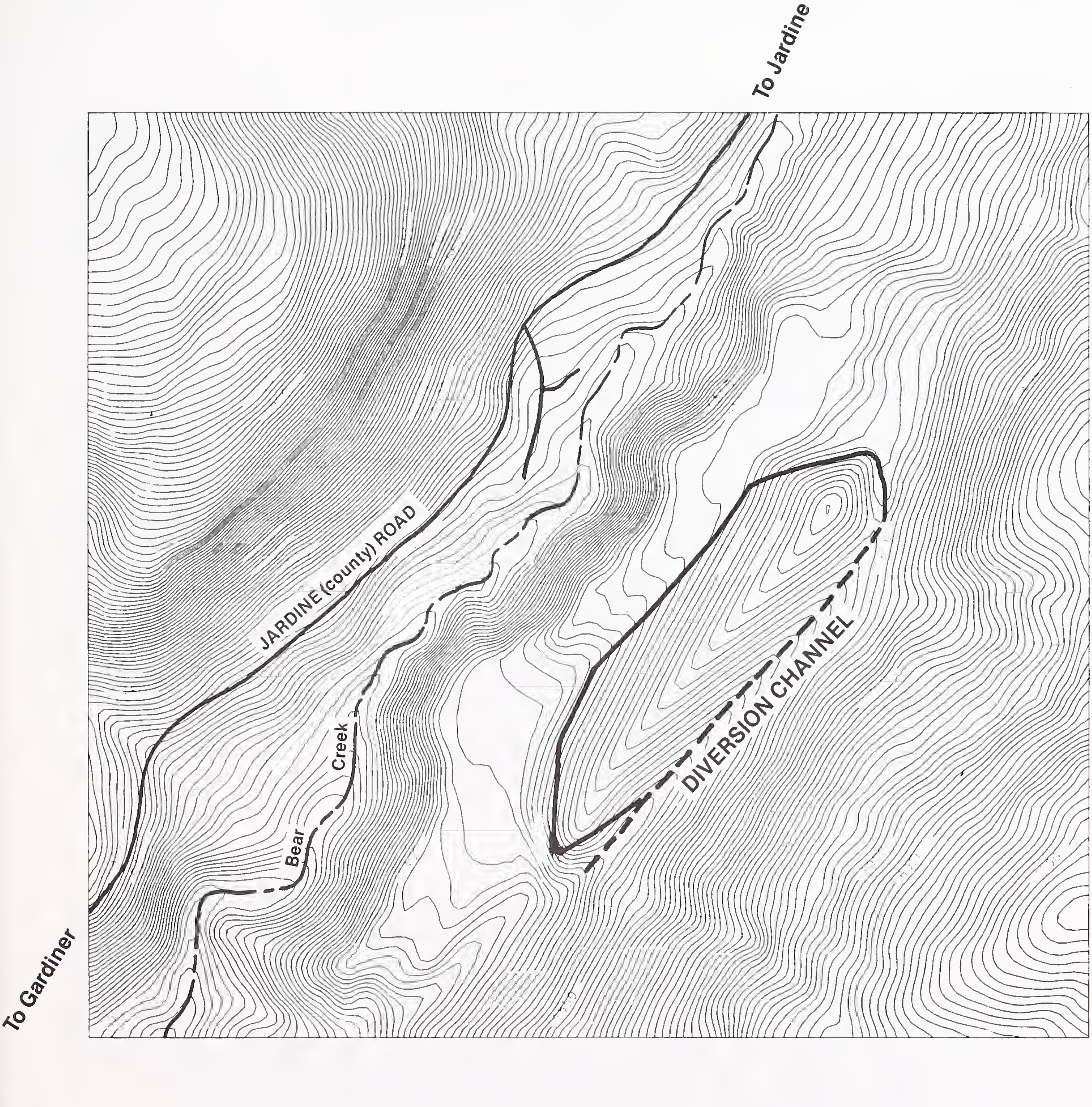

Figure III-2: The proposed tailings dump would ultimately alter the existing topography to the extent shown here.

Gullies may develop on the reclaimed dump surface in places where runoff waters concentrate. Because the dump would be reclaimed in stages, the applicant would be able to treat gully erosion immediately during the initial stages of development. Adjustments to undesirable drainage patterns that develop during operations and revegetation of the reclaimed dump surface would minimize gully development after reclamation is completed.

Earthquakes

A strong earthquake within ten miles of the project could create peak ground acceleration of between 40 and 50 percent of gravity (Algemissan and Perkins in Qamar and Brenninger, 1979; Bolt and Abrahamson, 1983). Because construction standards for proposed buildings are not given in the project application, it is not known to what standards the buildings would be designed and built. Of particular concern, because of the potential for a spill into the environment, is the mill facility. Buildings not constructed to accepted earthquake standards would pose both a safety and environmental hazard.

A strong earthquake could also rupture the clay and membrane liners of the tailings dump. However, the tailings dump itself would not be susceptible to mass failure even during a strong earthquake as long as the tailings remain unsaturated. The proposed facility design for the tailings dump would eliminate the potential for liquifaction, slumping, or piping of the stored tailings as long as large amounts of precipitation or snowmelt do not infiltrate the dump. No significant infiltration of water into the dump would occur during or after operation of the project. Reclamation of the tailings dump would advance in stages after tailings deposition. The reclaimed surface with clay cap, topsoil, and vegetation would limit moisture infiltration. At any given time during mine operation, only a small area (5 to 9 acres) would be unreclaimed. Infiltration of water over this small area would not affect stability of the dump.

An emergency spill ditch would adequately contain spills should a rupture of the slurry line occur.

Subsidence

Although difficult to predict, it is unlikely that extensive expressions of underground collapse would be evident at the surface. Rock within the mine would ravell from the sides and top and limit subsidence to shallow overburden areas. The company would leave blocks of bedrock within the mine, which would help minimize collapse features and surface subsidence. Signs of underground collapse could eventually reach the surface, but would probably be shallow and spread out over a fairly large area. Such changes would not affect the utility of the land surface nor create a hazard, and would require hundreds or thousands of years to occur.

Mineral Hill is already honeycombed with past underground mining. All but one of the mine portal entrances have collapsed due to rotted timbers. The applicant could be required to backfill the abandoned mine entrances with waste rock when mining is completed. Backfilling of the mine entrance would

help minimize the surface evidence of any tunnel collapse, but would not entirely prevent it. Mineral Hill is covered by 50 to 150 feet of glacial material on the Bear Creek side of the mountain. Some minor settling may occur at the surface in the zone where the access tunnels and underground excavations are not backfilled and the overburden thickness is relatively shallow.

Mitigating Measures

--Stability of the diversion channel could be improved by covering the upper, gentler segment with small-sized riprap and the lower, steeper segment with larger (average 50-inch diameter) riprap. An alternative to larger riprap on the steep segment would be to lessen the channel slope by slightly modifying the shape of the tailings dump and by moving it a few hundred feet upstream (northeast).

--All buildings, especially the mill, should meet acceptable design criteria to provide protection against a strong earthquake that would be possible in the area. The unsaturated (vadose) zone beneath the proposed dump should be monitored to assure the integrity of the liner system (see Chapter III--Hydrology).

HYDROLOGY

Summary: The maximum quantity of water required by the project would be about 47,130 gallons per day, or 0.073 cubic feet per second. This quantity of water would be withdrawn from Bear Creek and would deplete the stream by a factor of 0.5 percent during periods of low flow. This depletion could potentially impact the amount of water available to maintain minimum instream flows depending on the outcome of the present adjudication process.

Soil erosion and sediment loading to Bear Creek are predicted to increase during construction and approach baseline levels by year three. Actual concentrations of total suspended sediment in Bear Creek would depend largely on prevailing weather conditions.

Sewage generated by the project would be treated by a septic-tank drainfield system located 100 feet from Bear Creek. A small increase in the concentration of total nitrogen would be expected in Bear Creek below the drainfield site.

Two historic tailings impoundments would be removed and placed within the proposed tailings dump. This action would result in a decrease in the loading of cyanide,

arsenic, and other heavy metals to the ground water system and Bear Creek.

Surface Water

Water Availability. The proposed project would require both potable and mill circuit make-up water. The total depletion associated with project operation would be about 21,130 gallons per day or 0.033 cubic feet per second (project application, 1984). An additional 26,000 gallons per day may be used to control fugitive dust (Air Quality Permit Application, April 1985). A total depletion of 0.073 cubic feet per second would not affect existing uses of water from Bear Creek, assuming the project receives a pre-1978 priority date during the current statewide water rights adjudication process. However, if the Montana Water Court assigns the project a post-1978 priority date, already-established, minimum-instream flow requirements would preclude further depletion of Bear Creek at least 8 out of 10 years.

Homestake Mining Company has submitted 25 water rights claims on Bear Creek totalling 201.6 cubic feet per second (Department of Natural Resources and Conservation, 1985), or about 6,000 times as much water as is needed to satisfy the requirements of the proposed project. The outcome of the adjudication process is uncertain at this time. However, impacts to existing water rights holders or to the existing environment associated with a total depletion of 0.073 cfs would be insignificant.

Sediment Yield. Construction of the new mine road, as well as surface disturbances at the proposed project site, are potential sources of soil erosion and increased sediment loading to Bear Creek. The potential for erosion was assessed and sediment loading below the project area was predicted. Predictions presented in table III-1 are intended to indicate trends or to compare management alternatives. To a lesser extent, they may provide quantified estimates of sediment yield.

Table III-1: Predictions of Sediment Yield (Tons/Year)

Impact to Bear Creek		Impact to Yellowstone River	
Year	Tons/yr	Year	Tons/yr
1	5,775	1	6,719
2	243	2	495
3	68	3	138
4+	68	4+	138

Results indicate that sediment loading to Bear Creek would be greatest during the initial construction period and would approach baseline conditions by the third year. The quantity of sediment reaching Bear Creek would be greatest during periods of spring runoff, and may approach concentrations between 4 and 140 milligrams per liter above baseline levels. Actual concentrations would depend largely on prevailing weather conditions as well as the effectiveness of the erosion control practices employed.

Sewage Disposal. Sewage generated by the operation is projected to be about 3,850 gallons per day and will be treated by a septic tank drainfield system. The drainfield site requires an area of about 26,000 square feet based on a loading rate of 1.2 gallons per day per square foot. The drainfield site would be located about 100 feet from Bear Creek. Final drainfield design must satisfy standards developed by the Department of Health and Environmental Sciences, 1984).

Total nitrogen is expected to increase in Bear Creek below the drainfield site (see table III-2). Properly constructed, the septic tank drainfield system would have minimal water quality impacts to Bear Creek.

Relocation of Existing Tailings. From the fifth to tenth years of operation the two existing tailings impoundments would be removed and placed within the proposed tailings dump. The old tailings from the small impoundment may be reprocessed at the mill before placement in the disposal facility (Steffen Robertson and Kirsten, 1984). Both existing impoundments are sources of ground water pollution. Ground water studies indicate that contaminants from the existing impoundments move downgradient toward Bear Creek (project application, 1984). Reclamation of the old tailings impoundments would result in a decrease in the loading of cyanide, arsenic, and heavy metals to the ground water system. Therefore, concentrations of these constituents would be expected to decrease in Bear Creek through time.

Table III-2: Predicted Nitrogen Loading to Bear Creek During Periods of Winter Low Flow*

Assumptions:	
Bear Creek low flow:	5 cfs
Point source discharge:	3,850 gallons/day
Treated waste concentration:	32 mg/l of nitrogen
Baseline conditions:	
Total ammonia:	<0.10 to 0.24 mg/l
Nitrates and nitrites:	<0.05 to 0.11 mg/l
pH:	7.8 to 8.25
Temperature:	0.8° to 1.1° Centigrade
Predicated impact:	
Total nitrogen (N):	0.038 mg/l

*Worst-case analysis below proposed drainfield site.

Several sources of arsenic contamination would be removed during construction of the proposed project (see Chapter III--Cultural Resources). This action would result in a decrease in the concentration of arsenic in Bear Creek. However, the concentration of arsenic in Bear Creek would most likely continue to be greater than naturally occurring levels due to the leaching of buried wastes along the creek (Larry Brown, Dept. of Health and Environmental Sciences hydrologist, pers. comm., March 3, 1985).

Ore Processing Reagents. A list of reagents that would be used in the milling process is presented in table III-3. A description of these reagents and their relative toxicity to humans and the environment is presented in appendix 7. Tailings generated from the ore beneficiation process would be backfilled in mine stopes (40 percent) and deposited in a sealed impoundment (60 percent). Potential levels of total cyanide draining from tailings following deposition could be as high as 1.31 mg/l (project application, 1984). At pH 5 the concentration of arsenic could be as high as 3.7 mg/l.

The potential for contamination of the environment by ore processing reagents and tailings would be reduced by the applicant's proposed tailings dump design, low permeability of the mine workings, and emergency spill contingency plans. Tailings would not be dewatered before backfilling; however, slurry water from the backfilled tailings would be controlled by ditches in the mine, collected in underground sumps, and pumped back into the mill circuit.

The slurry and backfill lines would be monitored by daily visual inspections and by continuous balancing of flow at the mill and process area to check for leaks. If a leak were detected, the system would be shut down. The slurry and backfill line pads would contain the spill and employees using onsite equipment would clean up the spill. With the exception of the sand backfill lines to the mine, pipeline pads would consist of slurry pipelines

Table III-3: Ore Processing Reagents and Rate of Application Based on a Production Rate of 750 tons of Ore Per Day

Reagent	Application rate (pounds/day)
Sodium cyanide	21*
Aerofloat 208	38
Aero 350 xanthate	105
Aerofroth 76	113
Separan NP10	75

Source: Project application.
*Based on a 20:1 ore to concentrate ratio (Olin Hart, Homestake Mining Company geologist, pers. comm., March 19, 1985).

fixed to a support built on a 14-foot-wide trench. The trench would be unlined, with a crest of one foot and a slope of 0.04 percent (project application, 1984).

If the slurry and return water system were shut down, provisions would be made for the pressure portion of the lines to drain back to the mill or divert into the 1,050 level of the mine. The gravity section would drain to the process area. The slurry and backfill lines would be free flowing; therefore, freezing would become a serious problem when the system is inoperative (project application, 1984).

Prevailing weather conditions, final design characteristics of the slurry and backfill line pads, and the efficiency of emergency shut-down procedures will determine the potential for contamination of surface water resources. The major concern during a spill would be sediment loading to Bear Creek.

Water Quality Monitoring. Five factors have been taken into consideration in making recommendations regarding an operational surface water monitoring program.

- --The proposed project is located in an environmentally sensitive area.
- --Arsenic contamination related to previous mining activities is well documented.
- --The proposed ore beneficiation process could use the potentially toxic chemical sodium cyanide.
- --Increased sediment loading to Bear Creek would be expected.
- --A septic tank drainfield system would be built near Bear Creek.

The operational surface water quality monitoring program would be based on an evaluation of these factors. Operational monitoring would occur at stations 001 and 010 (see figure II-6) for each year of operation unless otherwise noted. The program would involve the following steps.

- --Monitor baseline water quality parameters seasonally (winter, spring runoff, summer low-flow, fall).
- --Monitor flow, arsenic, iron, manganese, sulfate, and pH monthly.
- --Monitor for presumptive cyanide at stations 008 and 010 daily. Because only one surface water quality sample for cyanide was collected during the baseline evaluation, additional samples should be analyzed before starting operations.
- --Monitor sediment monthly, as well as weekly during spring runoff, beginning with construction and continuing until the end of the third year of operation.
- --Monitor nitrogen and fecal coliform bacteria immediately below the proposed drainfield area monthly for the first three years of project operation. Seasonal sampling should be made thereafter if no degradation of baseline water quality is observed.
- --Statistics, including mean, median, range, high and low values, and number of times measurements exceed criteria, should be tabulated and forwarded to DHES and DSL on a quarterly basis.

Ground Water

Potential Sources of Ground Water Contamination. The type and concentration of substances in solution that might be expected from leaching of tailings were estimated for the proposed project by performing a batch extraction test at pH 5 on pilot plant test tailings (Steffen Robertson and Kirsten, 1984). Data presented by the applicant indicate the tailings effluent should have moderately high pH and high total dissolved solids. Leachate from the batch extraction test contained elevated levels of cyanide as free cyanide, arsenic, and manganese. Results of the batch column test are presented in table III-4 (Steffen Robertson and Kirsten, 1984). Although these test results cannot accurately predict the expected water quality of the seepage and return water ponds, they can be used to identify parameters that may exist in concentrations above established quality criteria.

There are two potential sources of ground water contamination. One is direct seepage from the tailings dump. The other is the production of leachate in mine workings and backfill that could percolate through bedrock fractures to the Bear Creek alluvium.

The potential for seepage through the tailings dump and subsequent contamination of the alluvial ground water system was evaluated. Results of this evaluation indicate that, if properly constructed, a seepage control system comprised of natural foundation material mixed with bentonite, overlain by a synthetic membrane liner on which a drainage system is placed, would effectively prevent seepage from entering the ground water system (United States Environmental Protection Agency, 1974). During the life of the mine, the drainage system would collect and recycle any leachate percolating down through the tailings. Reliability of liner performance after final reclamation would not be an issue because reclamation would effectively limit recharge to the tailings dump.

Table III-4: Chemical Analysis of Batch Test Leachate and Supernatant

Parameter	Leachate (1:1 extraction ratio at pH 5) (mg/l)	Supernatant (mg/l)
Total dissolved solids	600	550
Sulfate	145	195
Free cyanide	0.14	<0.05
Iron	0.08	0.12
Arsenic	3.7	1.8
Chromium	<0.01	<0.01
Copper	<0.01	<0.01
Manganese	0.07	0.02
Nickel	<0.05	<0.05
Zinc	<0.01	<0.05

Source: Steffen Robertson and Kirsten, 1984.
Concentrations in milligrams per liter.

Assuming a bedrock conductivity of 1×10^{-4} feet per day and a hydraulic gradient of .25 feet per foot, the movement of water through Mineral Hill would be less than one inch per year. The movement of water in fracture systems may be considerably greater. Based on tailings characteristics and existing water quality in Bear Creek, seepage rates necessary to violate established water quality criteria were developed. Results of this analysis indicate that seepage rates greater than 22 gallons per minute would violate water quality criteria for arsenic during periods of winter low flow.

Acid-mine Drainage. For acid-mine drainage to occur there must be a source of 1) iron sulfide (generally pyrite), 2) oxygen and 3) water. The physical characteristics of the mine itself must interact to produce acid and then allow it to drain from the mine (U.S. Forest Service, 1980). If any one of these three factors is absent, acid drainage cannot occur.

Information provided by the applicant suggests that the availability of water in the mine workings would limit acid drainage. Previous mine development established eight working levels in Mineral Hill between elevations of 6,601 feet and 7,113 feet. The existing workings do not produce appreciable amounts of water; however, a small seep near a portal at 6,601 feet produces a few gallons per minute (Olin Hart, Homestake Mining Company geologist, pers. comm., March 19, 1985). The applicant has proposed five new working levels between 7,263 feet and 6,663 feet. Therefore, the lowest proposed level is about 62 feet above the only documented source of water and 150 feet above Bear Creek.

Water Quality Monitoring. Baseline ground water quality data have been collected from a network of eight monitoring wells (figure II-6). Six of these wells are located downgradient of the proposed tailings dump site; one is beneath the site; the other is upgradient near the proposed mill site.

The density of wells in the baseline study was not intended to conform with criteria established by EPA for operational monitoring of solid waste disposal sites (EPA, 1980). EPA recommends installing at least one monitoring well for every 250 feet of frontage.

Design and Reclamation of the Tailings Disposal Facility. The hydrology of the project site has a major input in the design and operation of the tailings disposal facility. The proposed method of dewatered tailings disposal requires that the tailings remain dry after deposition. Therefore, a series of water balance calculations were performed that considered seasonal and annual variations and flood events in conjunction with a range of operating conditions (Steffen Robertson and Kirsten, 1984).

Tailings would be reclaimed in stages as material is deposited in the impoundment in a manner that should keep the total area exposed to the environment to a minimum. The main source of water coming into contact with the tailings is from direct precipitation on the unreclaimed portion of the impoundment known as the "active area."

Hydrology Cumulative Impacts

The U.S.D.A. Forest Service's small-sales program of logging 25 acres per year is a potential source of soil erosion and increased sediment loading to Bear Creek. The potential for erosion was assessed and sediment loading at the mouth of Bear Creek was predicted. Predictions presented in table III-5 are intended to indicate trends or to compare management alternatives. To a lesser extent, they may provide quantified estimates of sediment yield.

The cumulative long-term impact of the proposed mine and clearcuts would be that sediment concentrations in Bear Creek at the mouth would increase about 6 percent. By the year 1997, the proposed timber sales would be responsible for less than 1 percent increase in background sediment concentrations. The implication of these predictions are discussed in Chapter III--Fisheries.

Mitigating Measures

--Water in sediment ponds at the mine site should be used as irrigation water in reclamation and for dust suppression. This would decrease the potential for surface water contamination from sediment pond discharge, and decrease the total quantity of water required from Bear Creek.

--Road impacts related to soil erosion and sediment yield to streams can be mitigated (Farmer, 1976). For example, culvert discharge could be controlled or sediment ponds could be constructed below large fills or points where ditch discharge is dumped. Road cuts and fills could be revegetated and downspouts could be installed below culverts. Final road design and erosion control measures employed would depend on site-specific conditions. However, a series of mitigation measures may reduce only a maximum of 80 percent of the erosion related to road construction (U.S. Forest Service, 1981).

--Soil erosion could also be reduced by delaying earth moving and grading until July and seeding the disturbed area by fall. The proposed sedimentation ponds should be installed as soon as possible and the project site inspected as construction progresses.

--To prevent potential problems during a spill, oil petroleum products, industrial chemicals, and similar toxic or volatile materials would be stored in durable containers in an area surrounded by impermeable containment structures. The volume of the structures would be at least 150 percent of the total volume of material stored plus a sufficient volume for any water that could become impounded during a spill.

--An alarm system and automatic emergency shut-off valve would enhance the proposed system of detecting leaks by pressure balancing.

--Special designs for all backfill lines and return water lines that recycle water from sumps in the mine would prevent contamination of the environment.

Table III-5: Predicted Increase in Sediment Yield to Bear Creek in Tons/Year

Activity	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Natural sediment yield	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550
1982 baseline conditions (assumed constant)	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191	1,191
Jardine Mine and new road (1986)	5,775	243	68	68	68	68	68	68	68	68	68	68	68	68	68	68
Forest plan clearcuts (25 acres/year for 10 years)																
Roads:		192.0	51.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	5.0	5.0	5.0	5.0	5.0
Logging year 1:		3.3	1.7	1.4	0.9	0.4	0.2	0.0								
Logging year 2:			3.3	1.7	1.4	0.9	0.4	0.2	0.0							
Logging year 3:				3.3	1.7	1.4	0.9	0.4	0.2	0.0						
Logging year 4:					3.3	1.7	1.4	0.9	0.4	0.2	0.0					
Logging year 5						3.3	1.7	1.4	0.9	0.4	0.2	0.0				
Logging year 6:							3.3	1.7	1.4	0.9	0.4	0.2	0.0			
Logging year 7:								3.3	1.7	1.4	0.9	0.4	0.2	0.0		
Logging year 8:									3.3	1.7	1.4	0.9	0.4	0.2	0.0	
Logging year 9:										3.3	1.7	1.4	0.9	0.4	0.2	0.0
Logging year 10:											3.3	1.7	1.4	0.9	0.4	0.2
TOTAL INCREASE	5,775	438	124	89	90	91	91	91	91	91	91	78	76	75	74	73
Increase as a percentage over baseline conditions	485%	37%	10%	8%	8%	8%	8%	8%	8%	8%	8%	7%	6%	6%	6%	6%

--Based on information presented by the applicant, a quantitative evaluation of the flow of leachate through fractured bedrock would be speculative. In regard to this uncertainty, all wastes associated with the more toxic sulfide flotation should be disposed of in the lined tailings dump.

--In order to minimize the potential for acid-mine drainage mining activities should be limited to a depth of 6,663 feet. Mining below the 6,663-foot level should be considered only if additional hydrogeologic data support the contention that acid drainage would not occur at depths greater than 6,663 feet. A water quality sample of the existing seep should be collected at high and low flows, and a complete water chemistry analysis should be completed before starting the proposed project.

--If water is encountered between 7,263 and 6,663 feet, the applicant should grout or otherwise permanently seal off this source of water during reclamation.

--EPA criteria were evaluated with regard to the placement of existing wells, the high cost of well construction, the uncertainty involved in determining ground water flow patterns, and the design of the proposed tailings dump. Based on this evaluation, the operational monitoring program should consist of the eight existing baseline monitoring wells augmented by monitoring the unsaturated zone beneath the proposed dump. Unsaturated-zone monitoring would be inexpensive and more cost effective than drilling additional monitoring wells. Operational ground water monitoring design would be coordinated with DHES and DSL.

--An active area of less than six acres is recommended to reduce seepage and maintain confidence in the impoundment's ability to handle catastrophic precipitation/snowmelt events. A small active area would also help mitigate problems associated with wind erosion of exposed tailings.

--Water quality samples should be collected and analyzed from the seepage collection pond on a seasonal basis. This information would help tailor a more cost-effective ground water monitoring program and would provide valuable input for the reclamation process. After all residual solutions have drained from the tailings, both the seepage collection pond and return water pond should be filled with bank material and reclaimed.

AQUATICS

Summary. Increases in total suspended sediment (TSS) and total nitrogen in Bear Creek would have little effect on aquatic insect and algal communities. Changes, if any, would be temporary, and recovery would be rapid.

The project would not physically alter the channel or substrate of Bear Creek. All mining, milling, and tailings disposal activities would occur away from the creek. There would be no direct discharges of mine-related wastewater into the creek. Consequently, the project would have no direct impact on the aquatic system of Bear Creek from mine-related activities. However, below the

project, aquatic life in Bear Creek could be adversely affected by backfilled tailings and leachate from the mine workings if seepage rates exceeded 22 gallons per minute. The probability and magnitude of impact cannot be reliably predicted (see Chapter III--Hydrology).

Surface erosion on the project area and seepage from the septic system drainfield would increase TSS and total nitrogen in Bear Creek. TSS in Bear Creek during spring runoff may increase about 500 percent during construction. These levels would decrease to near-premining concentrations by year three (table III-5). Total nitrogen concentrations would increase only slightly below the drainfield site in Bear Creek.

Elevated concentrations of TSS during the initial years of the project may cause a decrease in macroinvertebrate density in Bear Creek below the project, but the diversity of organisms is not likely to change. This would occur because an increase in TSS would affect nearly all insect taxa equally.

Few pools (depositional areas) have formed in Bear Creek because of its steep gradient. Webster et al. (1983) found that these pools were the most adversely affected by suspended sediments. Therefore, the effects of suspended sediment on aquatic macroinvertebrates in Bear Creek would be limited. Because the general substrate would be unaffected (it would remain as coarse gravels with cobbles and boulders), macroinvertebrate populations would recover unimpeded once TSS concentrations approximated baseline conditions. Depending on weather conditions and mitigating measures (see Chapter III--Hydrology, Construction) implemented by the applicant, potential impacts from sediment could be substantially reduced.

The slight increase in total nitrogen concentrations would not adversely affect macroinvertebrates or algal communities.

Cumulative Impacts

Logging the Parker-Eagle and Pine Creek clearcuts would probably not have any greater effect on the aquatic life of Bear Creek than the mine itself, although TSS concentrations would generally be greater. The timing and transport of sediment would be similar to that described for the project proposal. Potential impacts from sediment could be substantially reduced with reasonable soil, water and land conservation practices applied during and after logging (see Chapter III--Hydrology, Mitigating Measures).

FISHERIES

Summary: The concentrations of total suspended solids (TSS) and total nitrogen in Bear Creek are predicted to increase as a result of mining activities (see Chapter III--Hydrology). However, these increases would be insignificant and are not expected to adversely affect the fishery.

Total Suspended Solids (TSS). Baseline concentrations of TSS at the mouth of Bear Creek during the 1981-1982 sampling period ranged between 1 and 13 milligrams per liter (mg/l). During project construction, the concentration of TSS may approach 140 mg/l over baseline. The actual concentration will depend on prevailing weather conditions and the effectiveness of erosion control practices employed.

This temporary increase in TSS is not expected to adversely affect the Bear Creek fishery. While no precise maximum concentration of suspended solids has been proven detrimental, Newport and Moyer (1974) determined that streams with sustained concentrations of between 100-400 mg/l were unlikely to support a good fishery. R. Liepolt reported that a trout fishery exists in a stream usually containing 19 to 23 mg/l of suspended solids. This fishery was not harmed by dredging operations that raised the concentration to about 160 mg/l for short periods (in European Inland Fisheries Advisory Commission, 1975).

Temporary increases in TSS would most likely occur during early spring, while rainbow x cutthroat spawning activities occur during mid-summer. Bear Creek is a high gradient stream; that the majority of sediment would probably flush through and dilute in the Yellowstone River. For these reasons, project activities would probably not affect the fishery or fish spawning in Bear Creek.

Nitrogen. The predicted increase in nitrogen loading is extremely small and concentrations of total nitrogen would be well below the quality criteria established for cold water aquatic life; therefore, no impact from nitrogen is expected.

SOILS

Summary: Biological impacts would occur in soils stored for prolonged periods. These impacts include a reduction or loss of soil microorganisms important to plant growth and nutrient cycling, a breakdown of soil structure, a reduction in organic matter, a loss of soil nutrients, and a loss of native seeds and other potentially active vegetative parts. Until vegetation is established, soil erosion would be moderate on the steep waste rock dump slopes, and minimal in other disturbance areas. Plant toxicity problems due to the chemical characteristics of soils or underlying waste materials are not expected.

Soil Quantity

The applicant would salvage a minimum of about 136 acre-feet of soil from the proposed disturbance area (table III-6). This would provide an average soil cover depth of at least 18 inches during reclamation. Actual replaced soil depths would vary depending on the type of disturbance. For example, soils would be replaced at a total depth of about 25 inches on the tailings

Table III-6: Soil Resources of the Proposed Disturbance Area

Soil mapping unit[1]	Acres proposed for disturbance	Percent of total disturbance area	Proposed total salvageable depth (inches)	Estimated salvage volumes (acre-feet)	Percent of total salvageable volume	Primary limiting factors
A--very gravelly loam, 40-60%	10.0	10.8	12[3]	10.0	7.3	Steep slopes, excess coarse fragments
A1--very gravelly loam, 30-50%	6.0	6.4	60	30.0	22.0	Steep slopes, excess coarse fragments
B--gravelly sandy loam, 15-25%	3.6	3.9	--[4]	--[4]	--[4]	Trace element contamination, excess coarse fragments
E--gravelly sandy loam, 13-25%	30.5	32.8	24	61.0	44.7	Excess sand, excess coarse fragments
M--fine gravelly sandy loam, level	13.7	14.7	30	34.3	25.2	Excess coarse fragments
S--very gravelly sandy loam, 10-20%	2.1	2.3	6	1.1	0.8	Excess coarse fragments
Est--gravelly sandy loam, 50-70%	0.9	1.0	0	0.0	0.0	Steep slopes, excess coarse fragments
Disturbed Areas[2]	26.1	28.1	--[2]	--[2]	--[2]	See footnote 2
TOTALS	92.9	100.0	NA	136.4	100.0	

Source: The above data was extrapolated from the Jardine Joint Venture permit application, 1984.

[1]Soil names are not official; they are used for reference only. Percentage figures following mapping unit names represent slope ranges where unit is found.

[2]Disturbed areas include old mine waste disposal areas, mine-related disturbances, and the Jardine townsite; some soils are intermixed with these disturbances and would be salvaged to a depth of at least 6 inches under the proposed plan. These areas would be identified in the field by the applicant's reclamation supervisor.

[3]For calculation purposes, it is assumed that type A soil would be salvaged to an average depth of 12 inches; however, actual salvage of this soil would vary between 6 and 20 inches depending on steep slope and coarse fragment limitations.

[4]Type B soils would not be salvaged in the vicinity of the proposed tailings pond; they have been chemically contaminated by the existing unreclaimed tailings. However, small areas of this soil type exist in areas proposed for new roads and slurry lines, and this soil would be salvaged in these areas to a depth of at least 6 inches.

dump, whereas soils on the five small waste rock dumps and in the facilities area would be replaced at a minimum depth of about six inches. Two factors that determine the necessary replacement soil depth include 1) the potential toxicity to plants from the underlying waste materials or, 2) in the case of the facilities area, the suitability of the subsoils for plant growth.

As mentioned above, the total soil volume of 136 acre-feet is the minimum amount expected to be salvaged. Although not shown in the table, an unknown amount of salvageable soil exists in the 26 acres mapped as "disturbance" in the soil survey (figure II-9). The disturbance mapping unit includes material such as old tailings and waste rock with no soil, but also includes the area in and around the Jardine townsite where the proposed facilities (mill, laboratory, warehouse, parking lots, etc.) would be located. The applicant's reclamation supervisor would identify any salvageable soils in this area before construction begins. These soils would be stockpiled next to the facilities area and would remain in place for the life of the operation. The applicant's plan to salvage favorable soil material located within the disturbance mapping unit would increase the estimated total soil volume given in table III-6.

Soil Salvage Plan and Soil Quality

The applicant proposes to salvage soils in one lift, with the exception of two soil types located in the proposed tailings dump area. These soils (types F and M) would be salvaged in two lifts; the separation of the two lifts would be based on the amount of coarse fragments (gravels and cobbles). The first lift (surface layers) would contain less than 45 percent fragments by volume. The second lift (subsoil material) would contain greater than 45 percent fragments. The purpose of the two-lift procedure in the tailings dump area is discussed later (see Tailings Dump section).

The salvageable soils in the proposed permit area are described in Chapter II--Soils. Trace elements are low in soils proposed for salvage; therefore, no plant toxicity problems are expected. Most of the soils have a high-sand and coarse-fragment content. Generally, this would indicate that the soils have low water- and nutrient-holding capacities. These characteristics could cause problems with plant establishment on the reclamation areas. However, the organic matter content of the soils in the areas proposed for disturbance ranges from moderate (1.3%) to very high (12.0%) in the surface 12 inches, with an average in the high range (4.3%) (see table III-7). Because of the high organic matter content, postmining water- and nutrient-holding capacities are expected to be adequate for revegetation, especially in the areas where soils are hauled directly (removed from one area and immediately respread over a reclamation area without stockpiling).

About 55 percent of the soils would be hauled directly; the remainder would be stored in stockpiles for at least 10 and possibly more than 21 years. The applicant's plan to direct-haul as much soil as possible would enhance the revegetation effort. Spread immediately over graded waste material, freshly stripped soil contains a number of favorable components. These components

Table III-7: Organic Matter Content of the Surface 12 Inches of Jardine Project Soils

Soil type	Sample number	Weighted average organic matter content, surface 12 inches (percentage)
A	SS-21	1.9
A	SS-8	4.6
A1	SS-28	5.3
B	SS-6	7.1
B	SS-14	12.0
E	SS-22	1.8
E	SS-10	1.3
M	SS-11	3.8
M	SS-11A	3.8
S	SS-15	1.7
S	SS-18	4.1

Source: The above data was derived from from the Jardine Joint Venture permit application, 1984.

include native plant seeds, rhizomes (underground stems) and other vegetative parts that grow after transport, and important soil microorganisms such as bacteria, fungi, and algae (Iverson and Wali, 1982; Howard and Samuel, 1979; Schafer, 1979; Beauchamp et al., 1975). These microorganisms play an essential part in decomposition and soil/plant nutrient cycling.

Other important constituents transported in directly hauled soil are mycorrhizae--structures that develop when certain fungi and plant roots form a symbiotic (mutually beneficial) relationship. The fungi absorb nutrients and water for the plants and the plants provide carbohydrates from photosynthesis for the fungi. In essence, the mycorrhizae serve as highly efficient extensions of the plants' roots. These organisms are an important consideration in maximizing plant productivity; most plants depend on them for adequate growth and survival. Malloch et al. (1980) state that four-fifths of all land plants form mycorrhizal relationships; some plants cannot succeed without this fungal associate (Trappe, 1981). Mycorrhizae reportedly increase plant productivity by as much as 400 to 500 percent (Davidson, 1976; Mosse and Hayman, 1971; Gerdemann, 1970). It therefore becomes clear how these organisms, as well as other components of directly hauled soil, assume important roles in the reestablishment of vegetation on disturbed lands.

Effects of Soil Storage

Some of the disturbances proposed at the minesite cannot be reclaimed until after the mine closes. These disturbance areas include the facilities area buildings, yards and parking lots, part of the tailings pond, mine roads and corridors, sediment control structures, the ore stockpile area, and the adit yards and associated waste rock dumps. Because of this, some of the soil salvaged during the construction phase of the mine would be stored in stockpiles for up to 21 years or more. The soil stockpiles would be stabilized with hydromulch and a seed mixture containing three grasses and one forb. This would prevent any excessive soil loss from the stockpiles due to wind or water erosion during the life of the operation.

Soil deteriorates when it is stored for prolonged periods, and may have little biological resemblance to native soils. Important soil microorganisms such as bacteria, fungi, algae, and mycorrhizae (discussed above) are greatly reduced in quantity or completely eliminated (Doerr et al., 1984; Fresquez and Lindemann, 1982; Liberta, 1981; Rives et al., 1980; Cundell, 1977; Miller and Cameron, 1976). The most common cause of reduced biological activity is the anaerobic (oxygen-free) condition created in the deeper portions of the soil stockpile (McKell, 1982).

In addition, prolonged soil storage causes breakdown of soil structure, affecting water and air movement through the soil, and reduces the organic matter content, which in turn decreases the water- and nutrient-holding capacity. Soil storage increases nitrogen losses and reduces the availability of other important plant nutrients due to a decrease in nutrient mineralization (Fresquez and Lindemann, 1982; Singleton and Williams, 1979; Davidson, 1976; Miller and Cameron, 1976). Seeds and other potentially active vegetative parts contained in the soil are also adversely affected (McKell, 1982).

Some of the adverse effects of prolonged storage would be offset by: 1) the relatively small size of the various disturbances proposed to be reclaimed with stored soil, 2) the naturally high organic matter content of the soils in the area, and 3) soil amendments proposed by the applicant in the reclamation plan.

Aside from the tailings dump, which is discussed later, the other mine-related disturbances are relatively small in size, ranging from 0.1 acre for the air shaft up to 12.0 acres for the facilities area. Because these are small, scattered disturbances, important soil microorganisms would naturally reinvade the replaced soils from adjacent, undisturbed sites in a relatively short period of time. Mycorrhizal fungi could reinvade these sites within one to three growing seasons. This estimate is based on research in Wyoming where reinvasion took somewhat longer, but the disturbances were larger and the sites drier (Loree and Williams, 1984a; Allen and Allen, 1980). Other types of soil microorganisms would probably reestablish quicker than the mycorrhizae, based on the work of Lindemann et al. (1984) and a review by Loree and Williams (1984b).

The applicant proposes to add two tons per acre straw mulch or one ton per acre hydromulch to the replaced soils. Other organic mulches (such as

sewage sludge, wood chips, and manure) may also be added depending on availability. In addition to the residual organic matter remaining in the soil after storage, the proposed organic amendments would aid in the reestablishment of soil microorganism populations (Lindemann et al., 1984). To a more limited extent, the organic amendments could also enhance the formation of mycorrhizae (Zak et al., 1982). Postmining water- and nutrient-holding capacities, although lower than in directly hauled soils, are expected to be adequate for vegetation reestablishment based on the proposed organic amendments in combination with any residual organic matter remaining in the soils after storage.

The applicant proposes to fertilize the replaced soils at a rate to be determined by sampling and analysis during reclamation. Fertilization would replace nutrients in the soil that have been lost during prolonged storage. The loss of seeds and other potentially active vegetative parts due to soil storage would be somewhat mitigated by the applicant's proposed revegetation plan (see Chapter III--Vegetation). However, vegetative species diversity would be lower than premining levels on soils that have been stored. Diversity would increase with time as plant species not included in the revegetation plan invade from adjacent, undisturbed areas (see Chapter III--Vegetation).

Tailings Dump

For the purpose of this evaluation, it is assumed that the tailings produced by the proposed operation would be chemically and physically similar to the existing tailings at the two abandoned ponds left from previous operations at the site. The existing tailings have a textural range between silt loam and sandy loam, and are low in coarse fragments. Aluminum and arsenic are two elements of concern in regard to potential postmining plant toxicity. The average water-soluble concentrations of aluminum and arsenic in the existing tailings are about 25 and 13 parts per million (ppm), respectively. Total (as opposed to water-soluble) arsenic concentrations are several orders of magnitude higher, with an average total concentration of about 13,500 ppm, or 1.3 percent. The reason for the great difference in arsenic concentrations is that most of the total arsenic is in the form of arsenopyrite, which is not easily weathered. Arsenopyrite has a low solubility in water; therefore, very little is available to plants.

Aluminum can be toxic to plants at concentrations as low as two ppm (Gough et al., 1979). Aluminum toxicity generally does not occur in soils or other growth media with a pH above 5.5, but is common at lower pH values and particularly severe below a pH of 5.0, where the solubility of this element increases sharply (Foy, 1974; Kabata-Pendias and Pendias, 1984). Aluminum concentrations well above two ppm and pH values below 5.0 are common in the existing tailings, and would most likely be common in the proposed tailings.

Arsenic is known to be toxic to plants such as alfalfa and barley at concentrations as low as two ppm (Vandecaveye et al., 1936 _in_ Gough et al., 1979). The National Research Council (1977) considers concentrations around five ppm toxic to other sensitive plants. Sandberg and Allen (1975) found that the toxicity of arsenic was greater in acid soils than those with an

alkaline pH, but this relationship may be affected by interactions with other elements, such as phosphorus. Almost all of the existing tailings have arsenic concentrations above 2 ppm and pH values on the acid side of the scale. Similar properties are also expected in the applicant's proposed tailings.

Although cyanide would be used in the gold extraction process, only small concentrations of this compound (<0.05 to 1.3 ppm) would be found in the tailings dump. In certain forms, cyanide can be extremely toxic to plants as well as other living organisms. However, several factors would exist in the tailings dump that would render any residual cyanide harmless to postmining revegetation. Residual cyanide would be chemically bound with iron and many other metals in the tailings; its mobility would be quite limited. Cyanide would also react with various forms of sulfur present in the tailings and would form thiocyanate, a relatively nontoxic compound (National Science Foundation, 1983). After soils are replaced and microorganism populations reestablish, residual cyanide in the plant rootzone would be biologically converted to nitrogen compounds and carbonate or carbon dioxide (Towill et al., 1978; Strobel, 1967 as cited in National Science Foundation, 1983). Because of the above, no plant toxicity is expected to occur as a result of cyanide.

The tailings alone (without soil) could be toxic to plants due to excessive amounts of aluminum and arsenic as well as excess acidity. This is evident from observations of the larger existing tailings pond where no volunteer vegetation exists, even several decades after abandonment. A good cover of vegetation does exist where soil was spread on the smaller tailings pond near Bear Creek. However, at this site in 1979, the Anaconda Company pushed some very gravelly and cobbly sandy loam soil over the toxic tailings and seeded the area with a mixture of grasses and forbs. The site was also fertilized at that time, but no other reclamation activities have taken place since.

To take advantage of the several years of plant growth at the smaller site, and because little information is available in the literature regarding tailings pond reclamation in Montana, the applicant funded a study to evaluate the vegetation and the chemical and physical characteristics of the two existing ponds (Westech, 1984). The applicant's reclamation plan, in part, is based on that study.

The soil used by the Anaconda Company to reclaim the small pond is similar to the soils that would be used by the applicant to reclaim the proposed tailings dump. Soil depths at the reclaimed pond vary from 3 to 24 inches. As might be expected, vegetative production is greater over the deeper soils, although canopy cover and frequency of occurrence is similar over both soil depth extremes. The roots of all species spread horizontally upon reaching the soil/tailings boundary, and seldom penetrate more than a couple of inches into the tailings. Vegetation growing on the small tailings pond was chemically analyzed for nine trace elements. The results of this analysis were compared to published results. Based on this comparison, the trace element concentrations found in the vegetation are within normal ranges (Kabata-Pendias and Pendias, 1984; Munshower, 1983; Ebens and Shacklette, 1982; Gough et al., 1979; Shacklette, 1972; Wallihan, 1966; Brewer, 1966; Labanauskas, 1966; Vanselow, 1966; Chapman, 1966; Reuther and Labanauskas, 1966; Jones, 1961; Williams and Whetstone, 1940).

The success of the vegetation growing on the small reclaimed tailings pond is attributed to several factors. These factors can be used to evaluate the applicant's reclamation plan. The cover soil serves as an effective physical and chemical buffer between the plants and the tailings. Neither significant acidification nor contamination by trace elements by upward migration from the tailings occurred after several growing seasons. Upward migration of potentially toxic trace elements was probably prevented by the extreme difference in texture between the fine tailings and the coarse soil. In addition, the chemical characteristics of the underlying tailings are such that substantial root penetration is discouraged. With an adequate cover soil depth, deeper penetration by the roots is apparently not necessary to obtain adequate amounts of water and nutrients.

As discussed earlier, minor root penetration did occur. This may have resulted from a seasonal, temporary increase in the pH of the tailings surface at the soil boundary. Spring moisture probably penetrates rapidly through the coarse soil and saturates a zone around the soil/tailings boundary. This "waterlogging" may have caused the pH to rise (Etherington, 1982; Black, 1968). A rise in pH would make trace elements such as aluminum less available to the plants, and this factor, along with the decrease in acidity, may have allowed some root penetration.

The applicant's reclamation plan expands on the techniques used by the Anaconda Company in 1979. Before placing salvaged soil over the tailings, the surface of the dump would be sealed by mixing one inch of bentonite clay with the top nine inches of tailings. After the bentonite application, the soils that have been salvaged in two lifts would be replaced in two lifts (see Soil Salvage and Soil Quality). The coarser subsoils would be placed on top of the tailings, and the finer topsoil would then be replaced at the surface. Because of the bentonite seal and the coarse subsoils, no significant upward migration of trace elements is expected; therefore, the cover soil would remain uncontaminated. Root penetration into the tailings of the proposed dump would probably be less than what has been observed in the small reclaimed pond. In addition to the chemical "barrier" created by the tailings, the mixture of bentonite and tailings would compact considerably under weight of the equipment used to respread the soils, seed, fertilizer, and mulch. The compaction would further discourage root penetration.

The applicant proposes to reclaim the tailings dump in five increments, leaving only about four to nine acres of exposed tailings at any one time. By doing so, soil can be directly hauled for reclamation over much of the dump. As discussed earlier, directly hauled soil promotes rapid revegetation and increases plant species diversity (see Chapter III--Vegetation).

Some erosion by water can be expected on the dump slopes, which are all about 33 percent. However, the applicant's proposed mulch treatment, along with the coarse-textured soils, would promote rapid infiltration and discourage runoff, preventing excessive soil losses. Where rills and gullies form on the newly revegetated area, the applicant would take corrective measures, including filling the rills and gullies, regrading, and reseeding. Soil erosion potential would decrease as vegetation becomes established.

Waste Rock Dumps

Five waste rock dumps are proposed, and would be located on the west side of Mineral Hill. The dumps would be next to the five mine portals, and would range in size from 1.5 to 2.1 acres. All five dumps would occupy a total of less than 10 acres.

Reclamation of the dumps would be conducted at the end of mining. However, if activities are complete at any of the four upper levels before the end of the operation, reclamation would begin at that time. Before soil redistribution, the slopes of the dumps would be reduced from 80 percent (the angle of repose), to between 50 and 67 percent. Soil that has been stockpiled next to each of the dumps would be spread over the dumps at a depth of at least 6 inches. Soil would be replaced at greater depths in areas where voids are created by larger rock fragments. The dumps would then be seeded, fertilized, and hydromulched (see Chapter III--Vegetation).

Waste rock has not been analyzed for any chemical parameters; however, no plant toxicity problems are anticipated. The waste rock is low-grade material mined through to access the ore (mineralized zone). Because the rock does not undergo any milling or processing, the trace elements are chemically bound within the rock and are not readily available to plants. This is evidenced by the old abandoned waste rock dumps on Mineral Hill where vegetation has naturally invaded without the addition of soil. The vegetation is sparse in some places, but this is attributed to the steepness of the slopes and lack of soil, not the rock chemistry.

Soil loss due to erosion is likely to occur off of the steep (50 to 67 percent) dump slopes during the initial reclamation years. Erosion rates would be moderate overall, and would decrease significantly after vegetation becomes established. In the interim, excessive soil losses would be partially offset by the short slope lengths, the rock content of the dumps, and the coarse texture of the soils to be used in reclamation. In addition, any rills and gullies that form on the newly revegetated dumps would be filled, regraded, and reseeded.

The applicant proposes to use hydromulch at a rate of 1,000 pounds per acre on the surfaces to aid in erosion control, soil moisture retention, and to increase organic matter. However, hydromulch alone is not very effective in controlling erosion. Hydromulch must adhere to the soil and hold the seed in place during heavy rainfall impact and wind; if it fails to do so, the other beneficial characteristics of the mulch are unimportant (Kay, 1980). Although not proposed by the applicant, the addition of a tackifier or erosion-control chemical would increase the effectiveness of the mulch.

The impacts of prolonged soil storage were discussed earlier (see Effects of Soil Storage), and would apply to the waste dump soils because they would probably be stockpiled for the life of the operation. However, because of the small size of these dump areas, important soil microorganisms would quickly invade from adjacent, undisturbed sites, improving soil quality. Plants not included in the revegetation mixture would invade from adjacent areas and would increase species diversity (see Chapter III--Vegetation).

Facilities Area

The facilities area would be the easiest to reclaim of all the disturbances due to the gentler slopes (10 to 20 percent) and because the proposed disturbances (buildings, stockpiles, parking lots) are much less drastic than at the tailings and waste rock dump sites. When mining activities are finished, the structures would be removed and the area would be graded and ripped to relieve compaction. Soil stockpiled next to the facilities area would be respread at a depth of about six inches. The area would then be seeded, fertilized, and mulched with straw at a rate of two tons per acre. The straw would be crimped vertically into the soil. (See Chapter III--Vegetation) Because of the gentler slopes and the proposed crimped mulch treatment, no significant soil losses are expected.

Due to prolonged soil storage, the same biological impacts discussed previously would occur here. However, the size of each disturbance within the facilities area is quite small. Therefore, reinvasion of microorganisms and native plants should take place within a couple of growing seasons, and soil quality would improve progressively.

VEGETATION

Summary. Mining would destroy 67 acres of native vegetation and 26 acres of previously disturbed land. The tailings dump, tailings sites from previous mining, and stored topsoil would be revegetated while the mine operates. With few exceptions, seeded grasses and forbs would establish an erosion-controlling ground cover. Douglas-fir would slowly invade the waste rock dumps, road and slurry line corridors, and edges of the tailings dumps. Planted Douglas-fir seedlings would also grow on the waste rock dumps. Several decades would be required for newly established Douglas-fir to reach premining heights. Problems that may be encountered during revegetation include introduction of weeds, occasional erosion on steep slopes, and damage to developing plants by wildlife and blowing tailings.

Mining, as proposed, would destroy 67 acres of native vegetation within the permit area comprised primarily of the big sagebrush/Idaho fescue and Douglas-fir types (table II-10). In addition, 26 acres of previously disturbed land would be removed.

Most of the affected land would be revegetated while the mine is operating. The 53-acre tailings dump would be revegetated in increments of 4.6 to 9.2 acres. The waste dump, soil stockpile sites, facility sites, and other disturbances would be revegetated within two years after the mine closes. At some point during mining, tailings that existed before the applicant's operations would be removed and the sites reclaimed.

The applicant hopes to provide a postmining environment that would provide wildlife habitat and livestock grazing land. It proposes to reestablish

80 acres of grassland and 13 acres of Douglas-fir forest to reach these objectives. All revegetated areas would be examined after planting. If revegetation failures are noted, the applicant would consult with DSL to develop solutions. Any modifications in the reclamation plan would require DSL's approval.

General Procedures for Revegetation

Revegetation would start with the ripping of highly compacted surfaces to improve moisture infiltration and root penetration. The tailings would then be covered with 24 inches of topsoil. Other areas would receive roughly six inches of topsoil. Topsoil quantity and quality are expected to be sufficient for plant establishment and growth (see Chapter III--Soils).

During spring or fall, fertilizer containing phosphorus and potassium would be disked into the soil. After subsequent seeding, two tons per acre of straw mulch would be anchored into the soil. Unless the applicant uses a "clean" mulch, introduced weeds may become established and compete with the desired species for nutrients and water (Kay, 1980). Nitrogen fertilizer would not be applied until the following growing season. Application rates for fertilizer would be based on site-specific soil tests.

Revegetation procedures for slopes over 33 percent would differ from those described above. A mixture of water and seed would be sprayed (hydroseeded) over these steep slopes. The mixture would also contain fertilizer. Hydromulch (wood fiber and water) would then be applied at a rate of one ton per acre. Small patches of soil on these areas would probably be eroded. Hydromulch does not offer complete protection from erosion (Kay, 1980).

Small portions of the waste rock dumps would not be seeded. These areas would be planted with Douglas-fir seedlings.

Livestock grazing would be prohibited within the permit area for two years after revegetation. This period of protection would be sufficient to prevent damage to grasses and forbs (Laycock, 1982). A few developing woody plants, however, could be lost to browsing livestock.

The large numbers of deer and elk (see Chapter II--Wildlife) would cause more damage to revegetated areas than would livestock. Rodents would probably be attracted by the straw mulch (Stoeckler and Slaubaugh, 1965) and may consume seeds and harm seedlings. The magnitude of problems caused by wildlife cannot be predicted. The applicant would attempt to control damage by using chemical repellents, selective fencing, or terminal bud protective coverings. These protective measures are at least partially effective in reducing wildlife damage (Lyon and Ward, 1982).

Blowing tailings may damage some of the vegetation planted on the tailings dump. Most damage would occur during the summer. If problems from wind-blown tailings are excessive, DSL would require the applicant to take corrective action, such as using a chemical binder on the tailings.

Seeding-Herbaceous Species

The applicant proposes to use two seed mixtures for final revegetation (table III-8). The waste rock dumps, and portions of the roads and slurry line corridors (totalling about 13 acres) would be drill seeded with 28.5 pounds per acre of mixture number 2. The remaining 80 acres of disturbance would be broadcast or drill seeded with mixture number 1. This mixture would also be used in reclaiming the tailings sites that were created by previous mining. (All slopes over 33 percent would be hydroseeded.) Stockpiled topsoil would be stabilized with hydromulch and grasses and clover (table III-9). After topsoil is distributed, the stockpile sites would be seeded with seed mixture number 1.

Species selected for revegetation are generally well adapted to the Jardine area and seeding rates fall within the range recommended by Brown et al. (1976). Development of an erosion-controlling ground cover is therefore expected.

Revegetation would increase production of wildlife and livestock forage in the disturbance areas. This increase would be due primarily to the revegetation of land disturbed before the applicant's operation. Other factors increasing plant productivity include fertilization, increased nutrient availability after soil disturbance, and reduced plant competition. The initial decrease in density of shrubs would increase livestock forage while somewhat reducing wildlife browse. Although long-term productivity would decline, it would remain above premining levels.

Revegetated areas would have lower plant diversity than premining forests and shrubby areas. Diversity, however, would slowly increase as plants invade from nearby, undisturbed areas. In addition, revegetation would improve plant diversity of previously disturbed lands.

Woody Species

The applicant's reforestation plan is primarily based on natural regeneration. Reestablishment of the Douglas-fir forest is expected on waste rock dumps and roads. Each of these disturbances is small and surrounded by undisturbed Douglas-fir forests. Seeds from existing trees would fall into the topsoil and, eventually, seedlings would develop. Douglas-fir is characterized by abundant seed production, effective seed dissemination, and prolific natural regeneration (Ryker and Losensky, 1983; Seidel, 1975).

Natural regeneration would be supplemented by planting Douglas-fir seedlings on the gentler uphill halves of the waste rock dumps. Each of the five waste rock dumps would be planted with about 430 containerized seedlings or about 860 bare-root seedlings (555 containerized or 1,110 bare-root seedlings/acre). The tree-planting sites would not be seeded with herbaceous species. This would reduce the competition that has been shown to limit seedling establishment (Larson and Schubert, 1969; Stewart and Beebe, 1974; Kittams and Ryker, 1975). Still, total survival cannot be expected. Mortality rates could range from 13 percent to 58 percent (Hite, 1974; Kittams and Ryker, 1975; Noble et al., 1978; Stein, 1984). Even with the highest mortality rate,

Table III-8: Proposed Seeding Mixtures for Revegetations

	Seed Mixture No. 1				Seed Mixture No. 2	
Common Name[1]	Rate PLS:[2] broadcast	Rate PLS:[2] drill	Percent of mixture: broadcast	Percent of mixture: drill	Rate PLS:[2] broadcast	Percent of mixture: drill
Meadow foxtail[3]	1.0	0.5	5.5	5.1	1.0	5.8
Beardless wheatgrass	4.0	3.0	6.8	9.4	4.0	7.2
Western wheatgrass	4.0	3.0	6.2	8.6	0.0	0.0
Slender wheatgrass[4]	4.0	2.0	8.6	8.0	4.0	9.2
Mountain brome[5]	10.0	5.0	9.8	9.1	10.0	10.4
Hard or Idaho fescue	2.0	1.0	16.0	14.9	2.0	17.1
Big bluegrass	1.0	0.5	11.9	11.2	1.0	12.8
Canada bluegrass	0.5	0.25	16.8	15.7	0.5	18.0
Green needlegrass	4.0	2.0	8.9	8.6	0.0	0.0
Indian ricegrass	0.0	0.0	0.0	0.0	4.0	9.2
Arrowleaf balsamroot	1.0	1.0	0.4	0.7	1.0	0.4
Alsike clover	1.0	0.5	9.2	8.7	1.0	9.9
Additional forbs	Trace	Trace	Trace	Trace	Trace	Trace
TOTAL	32.5	18.75	100.0	100.0	28.5	100.0

Source: Project application, 1984.

[1] See appendix 4 for scientific names.

[2] Lbs/acre of pure live seed.

[3] Pinegrass may be substituted in mixture 2.

[4] Elk sedge may be substituted in mixture 2.

[5] Indian ricegrass would be used on some sites.

Table III-9: Soil Stockpile Seed Mixture

Common Name	Rate PLS[2] hydroseed	Percent of mixture
Slender wheatgrass	8	16.9
Canada bluegrass	1	33.3
Hard fescue	3	31.5
Alsike clover	2	18.3
TOTAL	14	100.0

Source: Project application, 1984.

[1]See appendix 4 for scientific names.

[2]Pounds/acre of pure live seed.

premining Douglas-fir density (table II-12) would be exceeded. Roughly 40 to 100 years would pass before tree heights reached average heights that existed in premining forests.

Shrub seedlings would be planted at random locations throughout each waste rock dump. Thirty containerized or 60 bare-root seedlings would be used. The total number of seedlings would be equally divided among serviceberry, gooseberry, and snowberry. Survival would vary by species, with snowberry possibly having the highest survival (Fedkenheuer et al., 1980; Howard et al., 1979). Developing herbaceous plants from seed mixture number 2 would compete with shrub seedlings for water and nutrients. This would increase shrub mortality (Penrose and Hansen, 1981; Ferguson and Frischknecht, 1981; Van Epps and McKell, 1983). Over the long term, shrubs from surrounding undisturbed land would invade the waste rock dumps. Also, surviving planted shrubs would spread by root sprouting or seed dissemination. Sagebrush, followed by Douglas-fir, would eventually begin to invade portions of the reclaimed tailings dump.

Mitigating Measures

--Fall planting would give seeds a winter to meet the cold-induced dormancy requirements for germination required by some species (Brown and Johnston, 1978). Moreover, fall-planted seeds are in place to use favorable early spring moisture for germination. Moisture is available before seeding sites are accessible in spring due to snow and wet soils (Laycock, 1982; Brown et al., 1976). If the project is seeded during the spring, the advantages of fall seeding would be lost.

--Using the cleanest straw mulch available would reduce the chances of weed introduction. A mulch of native range hay would probably contain few weed seeds and would be an alternative to straw mulch.

--Scalping (removing grasses and weeds) or applying a short-term herbicide around individual seedlings would increase the survival of planted shrubs.

WILDLIFE

Summary. Along with previously developed land, mining would remove 67 acres of wildlife habitat. Displaced wildlife would find habitat nearby and reclaimed land would eventually provide suitable habitat. Elk and deer would initially avoid mining activity, but may, after habituation, move to habitats near the permit area. Significant disruptions of elk migrations are not expected. Mine-related traffic would increase road kills and may conflict with other vehicles during the late-season elk hunt. Increases in poaching and antler-collecting, combined with existing levels of these activities, would be detrimental to wintering big game animals. Proposed logging would only slightly increase negative impacts on elk.

Mining, in general, can have both direct and indirect impacts on wildlife. Direct impacts include habitat loss and subsequent displacement of animals, establishment of new habitats by reclamation, destruction of relatively nonmobile wildlife, and disturbances to nearby animals by mining activities. Indirect impacts include collisions between vehicles and wildlife (road kills) and demands on the environment (such as housing requirements, recreation, and poaching) that would rise as the human population increases.

Many of the elk and mule deer wintering in the Jardine area spend other seasons in Yellowstone National Park. Other individuals move to higher elevations north of the park. Any significant population changes occurring in the Jardine area would be noticed at distant points. The quantity and quality of winter ranges often limits big game population size (Mautz, 1978; Lyon and Ward, 1982). Animals may respond to nearby disturbances, increasing their energy use. If they use more energy than their bodies have stored for the winter, or more than is supplied by forage, their health will be affected. Energy otherwise available for reproduction will be depleted. Other problems associated with excessive disturbance include increased adrenocorticoid levels in the blood, reduced birth weights, and absorption or abortion of embryos (Geist, 1971). These responses would be damaging to the populations. However, few studies definitely link disturbances to changes in reproduction or other population parameters (Ferguson and Keith, 1982).

Direct Impacts

Wildlife Habitats. Mining would remove 93 acres of wildlife habitats. However, 28 percent of the disturbance area consists of previously developed lands. The loss of these lands would not have significant impacts on wildlife. Big game were not sighted in developed lands (Chapter II--Wildlife) and use by other species is probably light.

Mining would destroy 39 acres of the big sage/grass habitat, 19 acres of the Douglas-fir/big sage habitat, and 9 acres of the Douglas-fir/common snowberry habitat. The big sage/grass type is particularly important to wintering deer and elk. In fact, all three habitats are used by various wildlife species. However, amounts disturbed by mining represent only a small portion of available habitats (table II-10). Overall impacts of habitat loss on wildlife populations would be minor. Displaced animals could move into nearby and abundant habitats.

Much of the disturbance area could not be used by wildlife until reclamation is complete--at least 22 years after mining is initiated. However, the 53-acre tailings dump and some other sites would be revegetated during mining. Revegetation would establish a ground cover of herbaceous species (see Chapter III--Vegetation). These species, combined with invading woody plants, would eventually supply adequate forage for most animals. Cover availability, however, would be low until woody species mature. The revegetation of previously developed lands (existing tailings, building sites, etc.) would benefit wildlife.

Elk. The proposed tailings dump would be located within elk winter range (figure II-12). Most other mine facilities would lie just north of this range. The area covered by the tailings dump represents less than one percent of the 34 square miles of elk range. Although relatively small, the 60-acre habitats removed by the tailings dump are important to elk. Elk could compensate for lost habitat by using the nearby Douglas-fir and big sage habitats that would remain undisturbed. Revegetation of the tailings dump would eventually supply suitable elk habitat.

The potential for elk to be poisoned if they ingest tailings from the working face of the dump or drink from the seepage collection pond is a concern. The factors that would determine the likelihood of poisoning, however, are unknown. (These factors could include metal toxicities, attractiveness of salts in the tailings, quantities of materials that may be consumed, and frequencies of consumption.) In addition, elk would initially avoid the tailings area during mining operations due to human activities and noise (see below). Monitoring elk use of the tailings area would help to determine if a problem is occurring (see Mitigating Measures). After mining, reclamation of the tailings would eliminate the concern about poisoning.

Elk would respond to mining and associated activities by moving away from the project area. Elk initially avoid areas with substantial human influence (Knight, 1980; Ward, 1976; Irwin and Peek, 1983; Ferguson and Keith, 1979). The precise distance of the elk withdrawal cannot be predicted. However, studies by Ward (1976, 1985) suggest that elk prefer to be at least 1/2 mile from people on foot. For the proposed mine, 1/2 mile is a reasonable estimate. The figure lies within a range of withdrawal distances given by other studies (table III-10). It must be noted, however, that ungulates inhabiting national parks often exhibit less pronounced responses to human activity (Geist, 1971). Regardless of the distance, areas with visual barriers separating the mining activities and elk would probably receive the most use (Montana Cooperative Elk-Logging Study, 1976; Olson, 1983; Ward, 1985). Either topography or timber would serve as a suitable barrier (Lyon, 1975).

Table III-10: Influence of Human Activities and Roads on Elk

Human influence	Upper limit of influence	Elk response within upper limit	References
Moving automobile	0.1 mile	Increased heart rate	Ward and Cupal, 1979
Stopped automobile	0.3 mile	Increased heart rate	Ward and Cupal, 1979
People on foot	0.2 mile	Increased heart rate	Ward and Cupal, 1979
People on foot	0.5 mile	Avoidance of people	Ward, 1976, 1985; Ward et al. 1976
Seismic exploration	0.6 mile	Increased daily movements	Knight, 1980
Roads	0.125 mile	Avoidance of roads	Rost and Bailey, 1979
Roads	0.25 mile	Avoidance or roads	Hershey and Leege, 1976; Irwin and Peek, 1983
Roads	0.5 mile	Avoidance of roads	Perry and Overly, 1976, 1977
Roads	1.2 mile	Avoidance of roads	Morgantini and Hudson, 1979
Logging	4.0 mile	Displacement	Montana Elk-Logging Study, 1976

Noise from the mill would not be loud enough to disturb elk. Sound levels must be at least 54 dB(A) to elicit a response from elk (Ward et al., 1976; Ward, 1985). This sound level would exist only within 640 feet (0.12 mile) of the mill (Chapter III--Aesthetics, table III-27).

Elk have already been forced to adjust to the county road. Increased traffic on this road (see Chapter III--Transportation) would probably not cause further adjustments. Schultz and Bailey (1978) found that traffic volume did not significantly affect elk.

Mining and traffic on the county road are not expected to significantly disrupt traditional elk migrations. Existing roads and traffic apparently have no effect on elk migrations (U.S. Forest Service, 1982). Ward et al. (1976) indicate that only highways act as barriers to elk movements. However, elk may abandon some specific migration routes to avoid the project area and those road segments with traffic concentrations. Cut-and-fill slopes and debris created during road improvement could block some routes. Elk would probably select nearby alternative routes. Adams (1982) noted the use of alternative routes when traditional routes became unavailable. Alternative routes across the road would probably be located on saddles or gentle slopes or in heavy cover (Lyon, 1975; Ward, 1976).

Activities in the permit area and along the county road have the potential to affect elk behavior. Behavioral responses to human activity has been reported in other instances. Elk became more nocturnal and increased use of habitats with heavy cover to avoid humans (Geist, 1971; Schultz and Bailey, 1978; Morgantini and Hudson, 1979). The change in habitat use could lead to changes in food habits. Morgantini and Hudson (1985) found that grass consumption declined while browse consumption increased. The resulting decline in digestible energy could negatively affect elk populations during severe winters (Morgantini and Hudson, 1985). Westech (1984, p. 214) suggests that late-season hunting led to smaller group sizes. Cameron et al. (1979) noted a

similar decline in group sizes of caribou during construction of the Alaska pipeline. Geist (1982) explains how reduced group size could adversely affect foraging efficiency.

Eventually, elk would become accustomed to activity due to mining. Their behavioral responses would become less pronounced and they may begin using habitats closer to mining activities. Elk habituation to human presence has been reported by Ward et al. (1976), Schultz and Bailey (1978), Knight (1980), and Ferguson and Keith (1982). However, habituation would depend on non-threatening behavior in humans (Geist, 1971). Thus, non-mining activities, such as hunting, would complicate the habituation process.

When the mine closes, elk could return to reclaimed areas and traditional migration routes. After disturbances of elk habitat or migration routes stop, elk have been found to return (Montana Cooperative Elk-Logging Study, 1976; Ward, 1976, 1985; Knight, 1980; Adams, 1982).

Elk displaced by mining activity or habitat loss would move into adjacent habitats. They would compete for resources with the elk already in those habitats and with other wildlife. The magnitude of the competition and resulting population effects cannot be predicted.

Mule Deer. The tailings dump would cover a very small portion (less than one percent) of deer winter range (figure II-12). Other facilities would lie just north of this range. Mining would increase traffic on the county road that runs through the winter range.

The loss of such a small portion of winter range would not significantly affect mule deer. Although the deer would lose important big sage and Douglas-fir habitats, these habitats are abundant in the surrounding area and would be used by displaced deer. Revegetation of the tailings dump would eventually provide usable habitat. However, decades would pass before adequate woody cover and browse species are available (see Chapter III--Vegetation).

The presence of a tailings dump and seepage collection pond in mule deer range would create the same concerns and potential problems that were mentioned previously for elk. The same unknown factors would also be present. (See Elk subsection.) As with elk, monitoring deer use of the tailings area would help detect problems that may occur.

The noise and activity of mining may displace some nearby deer. Deer, as noted above, are expected to react less strongly than elk; their security requirements are significantly less than those of elk (Lyon and Jensen, 1980). Studies on deer response to roads (Rost and Bailey, 1974; Perry and Overly, 1977) suggest that deer use would decrease in all areas within 1/8 mile of mining. Competition between displaced mule deer and offsite wildlife would not be great enough to cause noticeable population changes.

Mule deer have already adjusted their habitat-use patterns to the county road. Increases in traffic probably would not further influence habitat use. Carbaugh et al. (1975) found that observations of white-tailed deer, generally more sensitive to human presence than mule deer, were not correlated with traffic volume.

Other Big Game Species. Black bears are considered common in the Jardine area (Westech, 1984) and probably range across the permit area. Bears would therefore lose a small amount of habitat to mining disturbance. Some bears may leave the area. The tailings dumps would approach a den along Bear Creek. Construction and reclamation of the dump could render this den unusable. However, the importance of this den has not been assessed. Garbage on the permit area would be stored in bear-proof containers and would not be allowed to accumulate. This would reduce the chances for bear/human confrontations.

Another wide-ranging predator, the mountain lion, would also lose a small amount of noncritical hunting habitat. After replanted vegetation matures, well after the mine closes, adequate bear and lion habitat would again be available in the disturbance area.

The direct impacts of mining on moose would not be significant. Moose were infrequently observed along lower Bear Creek near the permit area. However, only a small amount of forested habitat types, important to moose, would be removed. The mine would not directly affect bison or bighorn sheep.

Small- and Medium-Sized Mammals. Small mammal populations would be displaced or eliminated by mining. The straw mulch used during revegetation would initially attract small mammals to reclaimed areas (Stoeckeler and Slaubaugh, 1965). Revegetated lands supply suitable habitat (McCann, 1975; Hingtgen and Clark, 1984) and repopulation is expected. Medium-sized mammals, such as coyotes and porcupines, would be displaced from the disturbance area. Overall population impacts would be unnoticeable and reclaimed areas would eventually provide suitable habitat.

Birds and Reptiles. Mining may cause a red-tailed hawk pair to desert a nest along Bear Creek. Red-tails, especially early in their reproductive cycle, may not tolerate disturbances near their nests (Jackman and Scott, 1975). However, potential nest desertion may not be significant--use of the nest has not been established. The baseline report does not give specific locations for other raptor nests. It is possible that mining could remove an occasional tree nest. Hunting habitat for raptors would be slightly reduced while the mine operates. The applicant would request that Montana Power Company design power lines according to Olendorff et al. (1981) (Jerry Danni, Homestake Mining Company, pers. comm., June 5, 1985). Adhering to these criteria would avoid raptor electrocutions.

Songbirds would leave the disturbance area until revegetation has created sufficient cover. The invasion of sagebrush and Douglas-fir to supply the cover would take decades.

Mining would not affect waterfowl populations and would have minimal effects on grouse. Only a few rattlesnakes or racers would be killed or displaced.

Indirect Impacts

Road Kills. Traffic increases on the county road and on U.S. 89 (see Chapter III--Transportation) would increase road kills of wildlife. Low speed

limits would moderate the number of kills expected on the county road, even though traffic would increase with the project. Speed limits are higher along U.S. 89. However, traffic would not increase as much as on the county road. This would limit the increase in road kills along U.S. 89. Like the county road, U.S. 89 runs through deer and elk winter range. Deer and elk would account for most of the increase in road kills. However, all wildlife species would be exposed to a greater chance of being struck by vehicles. Raptors, for instance, could be hit while feeding on carrion on the road. Although the increase in road kills would be noticeable, significant effects on wildlife populations are not expected.

Housing Construction. Only a small amount of wildlife habitat in Park County would be lost to housing development. The locations of the 7.5 to 19 acres of new homesites cannot be predicted (see Chapter III--Land Use). Land ownership patterns, however, would allow development only on the edges of the Jardine study area's deer and elk winter ranges. Houses built in Livingston or below Emigrant would not affect wildlife that inhabit the Jardine study area.

Hunting. Even without the mine, hunting demand is expected to increase in the Gallatin National Forest (see Chapter III--Recreation). Mine-related population growth would add only a small amount to projected increases in hunting demand in the Jardine area. Most hunter use near Jardine comes during the late-season elk hunt. Actual hunting levels during this special season would be regulated by the Montana Department of Fish, Wildlife and Parks. This agency would also continue to regulate the hunting of other wildlife species.

Disturbance to wildlife during the late-season elk hunt would occur primarily within 1.5 miles of the county road. Westech (1984) observed most hunters within this distance of the road. All winter ranges east of Bear Creek have been closed to late-season hunting. The proposed mine is east of the hunting area and would not interfere with hunters. Mining-related traffic would add to the high level of hunting vehicles on the road. The total traffic may, therefore, rise above desired levels.

Other Recreation. Mine-related population increases would lead to more recreation in the Jardine area. However, most of the increase would occur even without the mine (see Chapter II--Recreation).

The most prevalent form of recreation after hunting in the Jardine area is antler collecting (see Chapter II--Recreation). (Although antler collecting is classified as recreation, some individuals apparently derive considerable profit from the activity.) Antler collectors probably spend much of their time on foot. The elk would respond to the collectors with increased heart rates or modified behavior (Ward et al., 1976; Schultz and Bailey, 1978; Ward and Cupal, 1979). Mule deer and bighorn may also respond with energy-consuming behavior.

The collectors are usually active in late winter or spring, when animals may be in weakened condition. Although increases in antler collecting due to mine-related population growth would be small, deer, elk, and bighorn populations may still be negatively affected. The level of stress currently created

by antler collecting may already be overstressing big game. (Tom Puchlerz, U.S. Forest Service and Jon Swenson, Montana Department of Fish, Wildlife and Parks, pers. comm., March 7, 1985). Westech personnel (1984) observed occasional harassment of the elk by antler collectors.

The mine-related population growth would slightly add to projected increases in camping (see Chapter III--Recreation). If past use patterns are followed, camping would be concentrated at the Eagle Creek campground (Westech, 1984). Disturbance effects on wildlife would, therefore, be highly localized. Other categories of recreationists spend little time in the Jardine area (Westech, 1984).

Poaching. Some of the 112 to 262 people added to the population by the mine would possibly engage in poaching (see Chapter III--Sociology). Klein (1979) noted that construction of the Alaska pipeline brought an increase in poaching. Illegal killing is currently a noticeable mortality factor of deer and elk. All wildlife species would be exposed to poaching, although big game species would be most affected. Some poachers would be tempted to enter Yellowstone National Park where poaching is already a problem (National Park Service, 1982). The applicant proposes several measures that would be at least partially effective in reducing poaching and wildlife harassment by their workforce. For example, the applicant would post state and federal hunting, fishing, trapping, and recreation regulations in conspicuous locations at the Jardine Mine. Furthermore, firearms would not be allowed in company vehicles, and unauthorized personnel would not be allowed to carry firearms (project application, 1984).

Cumulative Impacts

This section describes the cumulative impacts on elk and deer, the species of most concern. Cumulative impacts are the incremental impacts of the proposed action when added to past, present, and reasonably foreseeable future activities. Other activities could amplify the negative effects of mining. Some of the activities include developed and dispersed recreation, antler collecting, game hunting, timber sales, and activities along trails and roads (see table II-46). The analysis of cumulative impacts considers activities within the year-round ranges of elk and deer that use the Jardine area (cumulative effects analysis area).

Small timber sales and the West Gardiner Access Plan were identified as activities that, when combined with the mine proposal and other present and past activities in the analysis area, would create cumulative impacts to elk and deer.

Logging would affect 25 acres/year from 1987 through 1996. Some of the logging could occur within or adjacent to the 1981-82 elk winter range (figure II-11). Roughly 1/2 mile of permanent roads and up to 1 mile of temporary roads may be constructed in winter range. By itself, logging would not significantly affect elk. Winter range loss would be minimal and displacement would not be great enough to cause population effects. However, simultaneous mining and logging would tend to increase pressures on the elk population.

This pressure would be the result of habitat loss, displacement, and behavioral changes (see Chapter III--Wildlife--Direct Impacts). Also, logging in the Parker Point area has the potential to disrupt calving, reduce calving habitat, and displace a small resident elk herd.

Natural processes and management by the Forest Service would combine to reduce the impacts of logging on elk. Eventually, elk would habituate to human activities and native vegetation would invade logged sites. The Forest Service has committed to using management recommendations set forth in the Coordinating Elk and Timber Management handbook (Montana Cooperative Elk-Logging Study Committee, 1985). Furthermore, the Forest Service would close roads after logging and prohibit logging in adjacent drainages. In the Parker Point area, individual cutting areas could be located away from calving areas. All these practices would greatly reduce or, in some cases, nearly eliminate logging impacts on elk.

Because logging would employ only a small work force (see Chapter III--Employment), indirect impacts of logging such as road kills, housing construction, hunting, and other recreation would be insignificant; therefore, cumulative indirect impacts would be similar to mining by itself (see Chapter III--Wildlife--Indirect Impacts).

The timber sales would not significantly increase impacts to mule deer above those created by mining. Deer winter range presently falls outside of the sections that may be logged. Logging would, however, remove some habitats that are lightly used in seasons other than winter. Some of the management for elk, such as post-logging road closures, would also reduce impacts to deer. In addition, naturally revegetated logging sites could provide more deer foraging areas.

The West Gardiner access plan includes the option of opening up existing roads along Mill Creek and Mol Herron Creek. These roads are within the summer range of mule deer that may spend other seasons near Jardine. Elk that use the Jardine area do not use the area covered by the access plan (see figure II-11). Improved access would allow for more mule deer hunting; however, hunting would not cause a noticeable change in the deer population. Although opportunities for poaching and harassment would increase, the actual levels of these activities would not be high enough to affect deer. No deer habitat would be removed and displacement is not anticipated.

Mitigating Measures

--Monitoring deer and elk use of tailings and seepage water would allow early detection of any toxicity problems. The applicant would report observations of deer or elk consistently in the dump area or consuming tailings or water to DSL or the Department of Fish, Wildlife and Parks (DFWP). Both departments and the Forest Service would assist in monitoring the dump area. DFWP may choose to collect samples of internal organs from hunter-killed animals to check for metal accumulations. If poisoning occurs, a 7- to 7½-foot-tall, woven-wire fence constructed around the tailings area would prevent animals from entering the tailings area. The proposed four-strand, barbed-wire fence would prevent neither deer nor elk from entering the area. Appropriate angling of the fenceline would reduce interference with migrating elk.

--Because the early winter elk migration coincides with the late-season hunts, lowering mine-related traffic would also reduce conflicts between this traffic and hunting vehicles. As with the preceding mitigating measure, mandatory carpooling or bussing could be enforced.

--Road kills would be reduced by: (1) carpooling or bussing mine employees, (2) posting game crossing signs and enforcing lowered speed limits in problem areas, and (3) redirecting deer and elk movements in problem areas by fencing or other methods.

--Poaching and wildlife harassment by mine employees would be lowered if the applicant's policy specified disciplinary measures against violators. High visibility of law enforcement officers and strict enforcement of game laws would also reduce poaching.

--Prohibiting people from entering big game ranges from December 15 through May 15 would reduce harmful stress on mule deer, elk, and bighorn sheep.

--If major construction were limited to periods when elk use of the area is low (May 5 through December 15), elk could use habitat closer to the permit area.

--Modifications of the timber sales in the Parker Point area that would reduce impacts on calving include: (1) deleting or reducing selected logging units, (2) prohibiting logging and associated activities during the May/June calving period, (3) protecting small thickets of trees to provide cover, and (4) substituting selective cutting for clear cutting (Roberts, 1974). Cancelling the timber sale would be the surest way of protecting the calving grounds.

--Modifications of other timber sales that would reduce impacts include: (1) reducing cutting unit size, (2) limiting cutting units to areas outside of the elk winter range, (3) postponing logging until the mine closes or until elk become accustomed to mining activity, (4) prohibiting logging from December through May, (5) designing harvest procedures that would reduce impacts on elk habitat as outlined by Thomas et al. (1979), Hall and Thomas (1979) and Roberts (1974), and (6) incorporating road design and schedules that would lower impacts as discussed by Lonner (1983) and Black et al. (1976).

THREATENED AND ENDANGERED SPECIES

Summary. Mining would remove 67 acres of spring habitat used by foraging grizzly bears. The grizzlies would respond to habitat loss by moving into nearby, suitable habitats. After mine closure, revegetated lands would supply adequate foraging areas. Human activity would initially displace grizzlies from the vicinity of the permit area; however, some grizzlies would become accustomed to human activity and may forage near the mine, increasing the chances for encounters between grizzlies and humans.

Human/grizzly conflict could lead to management actions that may include relocation or destruction of some grizzlies. The number of conflicts and outcomes of management actions cannot be predicted.

Road-killed wildlife would attract bald eagles and grizzly bears, raising their chances of being struck by vehicles. Increased recreation, mostly caused by population growth unrelated to mining, would increase human/grizzly conflicts. Opportunities to poach grizzlies and bald eagles would increase as the human population rises.

Logging could increase cumulative impacts on grizzlies; however, specific impacts or their severity cannot be predicted until habitat effectiveness is determined and plans for the timber sales (including mitigating measures) are specified.

Like impacts to other species, impacts to threatened and endangered species can be classified as direct or indirect (see Chapter III--Wildlife). Direct impacts include habitat change, animal displacement, conflicts with humans at the minesite, and destruction of species and wildlife. Indirect impacts include collisions between vehicles and animals (road kills) and increased use of the environment (such as recreation and poaching) arising from increased human population.

Direct Impacts

Grizzly Bear. Mining would remove 39 acres of big sage/grasslands and 28 acres of Douglas-fir forests. Grizzly bears use these habitats in the spring as they search for carrion and succulent plants. The loss of this 67 acres of spring habitat would have minor impacts on grizzlies. The disturbed acreage constitutes less than 1 percent of the big sage/grasslands and Douglas-fir forests available in the assessment area. Grizzlies could find adequate spring foods in nearby, undisturbed lands. After the mine closes, bears could forage in the revegetated lands.

The potential for grizzly bears being poisoned if they consume tailings from the active face of the dump or drink from the seepage collection pond is of concern. Factors that would determine the likelihood of poisoning, however, are not known (these would include metal toxicities, attractive qualities of salts in the tailings, relationship between grizzlies and salt, and the amount and frequency of consumption). The probability of poisoning would be eliminated for those grizzlies that avoid the permit area (see below). Monitoring grizzly use of the tailings area would help to detect if a problem is developing (see Mitigating Measures). Final reclamation of the tailings would eliminate the concern about metal toxicity effects on wildlife.

Mining activity in the permit area is expected to displace grizzly bears initially. Grizzlies would retreat to those habitats where they could neither see nor hear the activities. A reasonable estimate of their withdrawal distance is one-half mile. Eventually, some grizzlies would become accustomed to

mining activities. These habituated bears may investigate the permit area for foods that people bring in, especially when natural foods are scarce. Although the applicant would use bear-proof garbage containers, the potential for some grizzly bears to forage in the permit area remains high. Subsequent confrontations with humans would require government agencies (U.S. Forest Service, U.S. Fish and Wildlife Service, and Montana Dept. of Fish, Wildlife, and Parks) to resolve the problem. The agencies would respond based on the specifics of each incident. In a worst-case scenario, the grizzly involved would be destroyed. Given the current unfavorable ratio between grizzly bear deaths and births in the Yellowstone area, even slight additions to total mortality are of concern.

Bald Eagle. Mining would have only minor direct impacts on bald eagles. Important bald eagle habitat along the Yellowstone River and Bear Creek would remain unaltered. The applicant would request that Montana Power Company design power lines using criteria in Olendorff et al. (1981), (Jerry Danni, Homestake Mining Company, pers. comm., July 16, 1985). Following these criteria would prevent bald eagle electrocution. Mining activity and traffic may discourage eagles from roosting in some trees. However, eagles would continue to find adequate roosting trees in undisturbed areas.

Peregrine Falcon and Gray Wolf. Mining would not directly affect the peregrine falcon. Peregrines are rarely recorded in the assessment area and the wetland habitats supplying potential hunting habitat would not be disturbed. Although a peregrine could nest in cliffs along Bear Creek, mining activity would not be close enough to the cliffs to create a potential for nest desertion. Power line design would prevent falcon electrocutions (see Bald Eagle subsection).

Mining would have no impact on gray wolves. Wolves have not been sighted in the assessment area and their presence in Yellowstone National Park is questionable.

Plant Species. Mining would not affect threatened and endangered plants. None of the federally listed species occur in the assessment area.

Indirect Impacts

Road Kills. Traffic increases on U.S. 89 and the county road (see Chapter III--Transportation) would increase chances of a grizzly bear or bald eagle being struck by a vehicle. The chances for collision would be greatest along U.S. 89, where speed limits are much higher. Road-killed wildlife (see Chapter III--Wildlife) could attract scavenging grizzlies or eagles to the roads. The Yellowstone National Park Bear Monitoring Office (1985) has documented instances of grizzlies being struck by vehicles along U.S. Highways 191, 287, and 89. During the late 1970s, a female and her cub were killed on U.S. 191 while feeding on moose carrion. The number of grizzly and eagle deaths due to collisions with vehicles cannot be predicted. However, the deaths of even a few of either endangered species would be detrimental.

Recreation. Recreation in the assessment area would increase as the human population rises. Most of the projected increase in recreation would occur even without mining (see Chapter II--Recreation). If future trends in recreation follow past patterns, hunting, antler collecting, and camping will account for roughly 90 percent of all recreation in the assessment area (see Chapter II--Recreation).

Any conflicts between recreationists and grizzlies which result in the relocation or death of a grizzly would increase concern about the Yellowstone grizzlies' welfare.

None of the threatened and endangered species in the assessment area can be legally hunted. However, the projected increase in hunting of other species could affect grizzly bears or bald eagles. With more hunters afield, the chances for grizzly/human confrontation would increase. Grizzlies may also be attracted to improperly stored food and game meat in hunting camps. The potential for black-bear hunters to mistakenly shoot a grizzly also would exist. Hunting would benefit grizzlies and eagles by creating additional food in the form of gut piles and wounded animals.

Like hunting, antler collecting increases the chances of grizzly bear and human confrontation. Prime antler collecting areas overlap grizzly spring range. However, confrontations would be limited by the relatively small predicted increase in antler collecting. Camping would increase primarily at the Eagle Creek campground. The potential for grizzly/camper conflicts would differ little from that existing before mining. Most of the projected increase in camping would be limited to the Eagle Creek campground (see Chapter III--Recreation).

Poaching. Some of the 112 to 262 people added to the population by mining (see Chapter III--Demography) may occasionally attempt to poach a grizzly bear or an eagle. Poaching increases as people use an area more; this relationship was noted during construction of the Alaska pipeline (Klein, 1979). Several grizzlies are killed illegally each year in the Yellowstone area (Yellowstone National Park, 1985; IBGST 1979-82). If poaching increases due to mine-related population growth, the Yellowstone grizzly population would be further kept from recovery.

Carrion along roadsides could attract grizzlies or bald eagles. These animals would be more visible and thus stand a greater chance of being poached.

Cumulative Impacts

Cumulative impacts are the incremental impacts of the proposed action when added to past, present, and reasonably forseeable future activities in the area. Other activities could amplify the negative effects of mining. Some of these activities include developed and dispersed recreation, antler collecting, game hunting, timber sales, and activities along trails and roads (see table II-46). The analysis of cumulative impacts on threatened and endangered species considers activities within the Hellroaring/Bear (Creek) Bear Management Unit. These impacts would combine with mining to increase

pressures on threatened and endangered species in the analysis area. In the case of this study, the threatened grizzly bear would be the threatened or endangered species most affected by cumulative impacts in the assessment area.

The U.S. Forest Service proposes to conduct small timber sales in the assessment area. These sales, affecting 25 acres per year from 1987 through 1996, would combine with mining to increase impacts on grizzly bears. Although shorter in duration, direct impacts caused by these timber sales would be similar to mining impacts: grizzlies would experience habitat loss, displacement, increased chances for conflicts with humans, and increased possibilities of being poached.

Logging could eventually affect about 250 acres of grizzly habitat (25 acres per year). During and immediately after logging, this acreage would not be available to grizzlies. However, natural revegetation would replace affected habitats eventually. Logging would encourage the growth of forage plants, improving habitat in those areas where cover is not limiting. The timber sales could be designed so that quality cover habitat would be available to grizzlies.

Chances of poaching or grizzly/human conflicts because of logging would be fewer than the chances caused directly or indirectly by mining because of the small number of loggers (see Chapter III--Employment). Also, indirect impacts are not anticipated because logging would only slightly increase the human population.

Grizzlies may become accustomed to logging activity. This would benefit the grizzlies by allowing them to use habitats adjacent to logging sites; however, the negative effect in this case would be increased chances for confrontations between grizzly bears and people.

Changes in the Yellowstone area's grizzly population resulting from human/grizzly conflicts cannot be reliably predicted. Although chances for these conflicts would increase, there is no way to predict the frequency of encounters. The variation in bear management actions and in grizzly behavior further complicates prediction capabilities.

Management by the U.S. Forest Service could reduce or eliminate the impacts of logging on grizzlies, thereby reducing cumulative impacts. The Forest Service and other agencies have been determining the effectiveness of habitats in the Yellowstone area (U.S. Forest Service, 1985). The more effective habitats meet the grizzlies' requirements for food, cover, and isolation from people. The Interagency Grizzly Bear Committee will specify a desired level of habitat effectiveness for the assessment area (Jerry Light, U.S. Forest Service, pers. comm., September 25, 1985). Forest Service land management will be designed to achieve this desired level. Another objective is to keep human-caused grizzly deaths at or below existing levels. Meeting these objectives could mean cancelling or modifying some land use activities.

Mitigating Measures

--Monitoring grizzly bear use of tailings and seepage water would help prevent toxicity problems. Any indications that grizzlies are consuming

tailings or water or frequenting the tailings dump area would be reported to DSL or the U.S. Forest Service. Both agencies, together with the Department of Fish, Wildlife and Parks and the U.S. Fish and Wildlife Service, could help the applicant monitor the dump area. If necessary, a bear-proof fence could be erected around the tailings and associated pond. (The proposed four-strand, barbed-wire fence would not prevent grizzlies from entering the tailings area.)

--Less carrion along roads would reduce chances for road kills of grizzly bears and bald eagles. Road kills of animals that attract grizzlies and eagles would be decreased by following measures outlined in Chapter III--Wildlife, Mitigating Measures. In addition, removing carrion from roads and roadsides would reduce grizzly and eagle activity near roads. Lowered activity would decrease the chances for collisions between vehicles and grizzlies or eagles. Reducing grizzly and eagle activity near roads would decrease poaching opportunities.

--Poaching and wildlife harassment by mine workers may be lowered if the applicant's policy specified disciplinary measures against violators. Disciplinary measures would be in addition to legal action taken by proper authorities. The possibility of legal action would also apply to people not working at the mine. Strict law enforcement of laws protecting threatened and endangered species and high visibility of law enforcement personnel would also help to protect grizzlies, eagles, and falcons.

--Attraction of grizzly bears to the permit area would be reduced if the applicant's garbage disposal and food storage plans followed criteria in Grizzly Bear Standards and Guidelines for the Gallatin National Forest (U.S. Forest Service, 1985b). The applicant could further decrease attractants by advising Jardine residents of proper garbage disposal and food storage practices. Providing residents with bear-proof containers could be part of the applicant's efforts.

CLIMATE

The small amount of particulate matter emitted from ground-level sources during mining and milling would not affect the climate of the area.

AIR QUALITY

Summary: With proper control, the predicted dust emissions would not adversely affect the air quality near Jardine. The estimated total suspended particulate (TSP) concentrations occurring during the operation would probably be well below all applicable Montana Ambient Air Quality Standards (MAAQS).

Construction Emissions

During the construction period, dust emissions would total about 212 tons, or 170 tons per year. Nearly 80 percent of this dust would be generated by general construction activities--for example, heavy equipment moving over exposed areas. Topsoil removal, access road traffic, and road maintenance would generate about 32 tons of dust per year, or 18 percent of total (table III-11). The applicant would water all exposed areas and roads to minimize dust. According to the EPA (1976) this would require complete coverage twice a day. Disturbed areas and stockpiles would be revegetated as quickly as possible, also reducing wind-blown dust.

Milling Emissions

Only small amounts of particulate would be emitted from the milling process. The emissions would be vented to the outside through either a scrubber or baghouse, which would trap about 98 percent of the particulate. The particulate emissions from the crushing, screening, and conveying would total about 2 tons per year (table III-12).

Table III-11: Construction Phase Fugitive Emissions

Activity	Uncontrolled emissions tons/yr	Controls BACT[1]	Percent control	Controlled emissions tons/yr
Topsoil removal	12.6	Minimize fall distance	0	12.6
Topsoil loading	0.7	Minimize fall distance	0	0.7
Topsoil dumping	0.1	Minimize fall distance	0	0.1
Topsoil stockpile	0.9	Revegetation	75	0.4
Disturbed areas	6.0	Revegetation	75	3.0
Construction emission	267.0	Watering	50	133.5
Access roads	24.4	Watering	50	12.2
Road repairs	14.6	Watering	50	7.3
	326.3			168.6

Source: Jardine Joint Venture Air Quality Permit Application, 1985.

[1] Best available control technology.

Table III-12: Process Particulate Emissions

Activity	Uncontrolled emissions tons/yr	Controls BACT[1]	Percent control	Controlled emissions tons/yr
Crushing	91.9	Scrubber or baghouse	98	1.8
Screen, convey, and handle	13.1	Scrubber or baghouse	98	0.3
	105.0			2.1

Source: Jardine Joint Venture Air Quality Permit Application, 1985.

[1]Best available control technology.

Mining

Emissions from controlled sources would total about 45 tons per year. Access road traffic and road repair would account for 84 percent, or 37.7 tons per year, of the dust. The other activities would contribute little to the particulate emissions (table III-12).

Tailings Dump

It is not known how much particulate would be emitted from the tailings. Using the wind erosion equation of Woodruff and Siddoway (1965), dust from tailings was estimated at over 15 tons per acre per year (on-file report, DSL, 1985). With an active face of five acres, 75 tons of dust per year would blow from the tailings dump. Using a tailings emission equation developed for the U.S. Environmental Protection Agency (1976), 6.8 tons per acre per year, or 41 tons per year would blow from the area. The Montana Air Quality Bureau recommends that an emission factor of 0.6 tons per acre per year be used. Using this emission factor, tailings emissions would be 3 tons per year. Dust from the tailings is estimated to be between 3 and 75 tons per year, depending on the emission factor used for calculations.

Regardless of calculation factors, the estimated amount of emissions from the proposed tailings would be similar to the dust blowing from the 6.2 acres of existing tailings. The existing air quality data indicate that concentrations of TSP are low (see Chapter II--Air Quality). Even if the proposed tailings doubled the present dust emissions, air quality standards would probably not be exceeded, as discussed below.

Total Suspended Particulate (TSP) Concentrations

Annual average and maximum 24-hour TSP concentrations were modeled in the Jardine Joint Venture Air Quality Permit Application (April, 1985). The model

predicted that the mine would increase the annual average TSP concentration outside the permit area by a maximum of 6.7 $\mu g/m^3$.

The maximum increase in 24-hour TSP concentrations outside the permit area predicted by the model would be about 35.4 $\mu g/m^3$, still well below the MAAQS of 200 $\mu g/m^3$.

Even if the dust emissions from the proposed tailings doubled the baseline TSP concentrations (52 $\mu g/m^3$), the resulting maximum 24-hour TSP concentration of 104 $\mu g/m^3$ and the resulting annual average TSP concentration of 40 $\mu g/m^3$ would still be well below MAAQS.

The modeling included receptors in Yellowstone National Park and the Absaroka-Beartooth Wilderness areas. The park is designated Class I under the Prevention of Significant Deterioration (PSD) regulations; the wilderness area is Class II. The maximum increase in annual TSP concentration predicted in the park is 2.6 $\mu g/m^3$. The maximum 24-hour increase predicted in 11.1 $\mu g/m^3$, while the second highest is 9.9 $\mu g/m^3$. These would be below the maximum allowable increases for a Class I area. The maximum allowable increases (increments) from the PSD regulations are not applicable here because this project is not considered a major stationary source. Reference to the increments is used for comparison purposes only. The maximum annual increase predicted in the wilderness area is 2.6 $\mu g/m^3$ and the maximum 24-hour increase predicted is 8.1 $\mu g/m^3$.

Lead concentrations would be small. Based on the ore analysis and TSP concentrations, annual lead concentrations in the air are estimated to be less than 0.001 $\mu g/m^3$, well below the MAAQS of 1.5 $\mu g/m^3$.

The gaseous pollutant emissions would be minor (table III-13). So, concentrations of these pollutants in the air would also be small.

Mitigating Measures

The applicant has incorporated a number of dust control measures in its application (table III-14). The emissions from the tailings may be a major dust source. To reduce the wind-blown tailings, a sprinkling system could be constructed to wet the tailings when necessary--during windy periods, for example--or, a chemical binder could be applied to the tailings. During these windy periods, tailings may be blown away as they are deposited. The amount of wind-blown tailings could be reduced by lowering the fall distance from the conveyor to the working face and placing a hood on the conveyor.

The access road from Gardiner to Jardine is predicted to be a major dust source. The air quality permit application states that this road would be treated with a dust suppressant. However, the applicant has not committed to this treatment. If the road is treated, total dust emissions would be reduced significantly.

An air quality monitoring network of high-volume air samplers situated upvalley and downvalley of the permit area would insure compliance with MAAQS. The Air Quality Bureau may also stipulate other control measures in the Air Quality Permit.

Table III-13: Gaseous Pollutant Emissions

Source	Extent of activity	Particulate	Carbon monoxide	Sulfur oxides	Hydro-carbons	Nitrogen Oxides
		Tons per year				
Ammonium nitrate fuel oil explosive	97.5 tons/year	--	3.3	0.1	--	0.8
Diesel exhaust	156,520 gallons/year	1.4	7.2	2.4	3.0	41.0
Access road traffic	290,500 vehicle miles/year	0.2	11.8	--	1.0	1.4
TOTAL		1.6	22.3	2.5	4.0	43.2

Sources: Jardine Joint Venture Air Quality Permit Application, 1985; U.S. Environmental Protection Agency, 1975.

Table III-14: Mining Fugitive Emissions (Excluding Tailings)

Activity	Uncontrolled emissions tons/yr	Controls BACT[1]	percent control	Controlled emissions tons/yr
Topsoil stockpiles	0.9	Revegetation	75	0.2
Disturbed areas	7.5	Revegetation	75	1.9
Ore/waste dumping	0.2	Minimize fall distance	0	0.2
Coarse ore stockpile	1.9	Watering	50	1.0
Haul roads--waste	0.1	Chemical stabilization	85	0.0
Haul roads--ore	16.2	Chemical stabilization	85	2.4
Access roads	202.5	Chemical stabilization	85	30.4
Road grading	14.6	Watering	50	7.3
Vehicle exhaust	1.6	Operation	0	1.6
TOTAL	248.5			45.0

Source: Jardine Joint Venture Air Quality Permit Application, 1985.

[1] Best available control technology.

INCOME

Summary. Mine employment would add $3.4 million annually to Park County income once the mine is at full employment. Secondary job increases would add between $359,936 to $506,160 to total county income.

Direct Employment Income

Project construction employment income is estimated to be about $1.4 million. This income would be paid to construction crews the last three quarters of 1986 and first three quarters of 1987. The total amount paid to Park County residents would depend on the number of local persons hired and the skill level and wage rates of construction jobs held by local workers. Between 25 and 50 percent of construction income could be paid to nonlocal workers who would spend the majority of these wages outside Park County.

Mine operation employment income would add $3.5 million to annual income in Park County. The total level would fluctuate, depending on wage increases and the level of mine employment. Including the wages of the 10 employees currently working on the project, the total project payroll would be $3.7 million when the mine is operating at projected full employment. Total mine-related income would fluctuate over time depending on wage increases, and employment levels; however, it would add between 1.4 and 4.3 percent to forecasted levels of baseline Park County income (Mountain International, Inc., 1984, vol. 2, p. 124).

Induced Employment Income

Mine employment and resulting increases in consumer spending in Park County would be expected to foster between 32 to 45 new service sector jobs (see Chapter III--Employment). Table III-15 shows the average wage for all Park County jobs and for selected business sectors. In 1982, the average wage paid in Park County was $13,704. Jobs in service sectors earned slightly less. Retail trade jobs were paid an average of $10,085 while jobs in the service sector were paid $11,248.

Table III-15: Average Wages Paid in Selected Sectors of Park County Businesses in 1982 (in 1982 dollars)

Sector	Wage
All jobs	$13,704
Retail trade	10,085
Services	11,248

Source: Bureau of Economic Analysis, 1984, tables 5 and 25.

In 1989, one year after the mine is projected to reach the full employment production level, induced-employment income would average $359,936 to $506,160 annually, less than 1 percent of projected total county income that year. Mine-induced employment would not grow beyond 45 service sector jobs (see Chapter III--Employment); therefore, mine-induced secondary income would not grow substantially, either.

Temporary or Permanent Closure

The mine could close temporarily during its operation; such closures would cause county income to drop. The amount of the decline would depend on the length of closure and availability of unemployment benefits. If the temporary closure lasted long enough, other business sector income could decline if consumer spending fell due to the mine closure. After the mine closes permanently, income would fall to a level where it would have been without the mine.

Cumulative Impacts

The two timber sales planned by the U.S. Forest Service in the Gardiner-Jardine area could provide 3 to 22 additional jobs for local residents from 1987 to 1996. Assuming an annual average wage of $18,000, logging jobs could add $54,000 to $396,000 to total county income. Such increases represent less than 1 percent of total forecasted income without the timber sales.

EMPLOYMENT

Summary. The project would add 140 new jobs to the Park County economy. An additional 32 to 45 jobs would be created due to increased income and spending from new mining jobs.

After permanent closure of the mine, employment would decline to what it would have been without the mine. Temporary closures of the mine may cause service sector businesses to lay off other employees, if the closure lasts long enough.

In the cumulative scenario, logging may add 3 to 22 seasonal jobs from 1987 to 1996. Crew sizes will be small and the operations will be short-lived. Some of the jobs may be filled by Park County residents.

Jobs. At full operation, the project would employ 150 workers, 10 of whom are already employed at the project site. Seventy-five would work in the mine, 25 at the mill, 20 at the maintenance shops, and 30 would be management, clerical, and laboratory personnel. During the 18-month construction phase, up to 55 construction workers would be hired by the applicant (Mountain International, Inc., 1984, Impact Plan, pp. 37 and 69).

The applicant has committed to hiring and training as many local people as possible (Mountain International, Inc., 1984, Impact Plan, p. 15). The applicant would attempt to hire 80 percent of the workforce (120 employees) from within Park County and from Mammoth, Wyoming. However, project impact analyses have been determined for two scenarios, varying from 80 percent local hire to 50 percent local hire (see also Sociology, Income, Transportation, and Community Services). In each of the scenarios, the balance of the workforce is assumed to be nonlocal people who move into Park County.

The project would add between 182 to 195 new jobs to the Park County economy--150 mining jobs and 32 to 45 service-sector jobs. The range of service-sector jobs assumes that three to five mining jobs would provide enough additional consumer spending in Park County to foster one other additional job. Mining is considered a basic industry; that is, its products are purchased by people and firms outside the local economy. New jobs created due to growth in basic industry employment are called derivative or nonbasic jobs. Table III-16 shows the estimated number of jobs created by the project employment during its first five years.

Only permanent operations jobs have been used to estimate derivative employment because the construction force is small and the construction period too short to foster long-term, nonbasic job creation (Mountain International, Inc., 1984, vol. II, p. 118). Nonbasic jobs lag one year to reflect the time necessary to develop or expand services in response to increased spending due to new basic-industry jobs. In addition, each basic-industry job is assumed to have the same impact on derivative employment whether it is filled by a Park County resident or a person from outside the county. This rationale is based on several assumptions. It is assumed that local hire would add the same amount of new spending to the Park County economy as nonlocal hire, because the local person hired would be currently unemployed or would leave a job that would be filled by another county resident.

Over the life of the project, between 32 to 45 new jobs could be added to the Park County economy as a result of increased mining employment. The low prediction is consistent with estimated historic and projected ratios of basic

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Table III-16: Estimated Number of Jobs Created During First Five Project Years

Year	Number of operations jobs--JJV project	Derivative employment		Total	
		Low	High	Low	High
1986	10	0	0	10	10
1987	34	2	3	36	37
1989	138	7	10	145	148
1990	150	29	41	179	191
1991	150	32	45	182	195

Source: Mountain International, Inc., Impact Plan, 1984, p. 38. Department of State Lands, unpublished working papers, May 1985.

to nonbasic employment in Park County (Mountain International, Inc., 1984, vol. 1, pp. 269 and 276). The high estimate is based on predictions of mining-induced employment impacts for other rural Montana counties (Department of State Lands, unpublished working papers, January 1985 [Stillwater County], January-February 1985, [Big Horn County]).

It is unlikely that project employment would foster more than 45 derivative jobs. Gardiner and Livingston are within the market area of two large trade centers--Bozeman and Billings. If Park County residents and businesses shop elsewhere, derivative jobs would be limited (Mountain International, Inc., 1984, vol. 1, p. 281).

Temporary or Permanent Closure

The project would have an estimated life of 20 years. During the 17th year, employment would be scaled back as mining ceased and final reclamation began. At the end of the 20th year, the mine would close.

After the mine closes, former project employees would either leave or remain in the county. Employees remaining would find other jobs, use available unemployment benefits, or retire. Those unable to find other employment may leave the county to find other jobs.

Total employment in Park County would gradually adjust to a level that would have occurred without the mine. Once the mine closes, total county income and personal spending would decline to what it would have been without the mine. Service industries would adjust to the reduced level of spending by scaling back employment and output. Total adjustment would take several years.

During its operation, the mine could experience temporary shutdowns or periods when employment may be cut back. Cyclical production slow downs are difficult to predict because such events are due to a combination of circumstances including fluctuations in metal prices, labor costs, production costs, profitability of the company, and effects of national and international political and economic events.

During temporary shutdowns or reductions in force, unemployed mine workers could wait for the mine to reopen or jobs to be reinstated. The length of time unemployed miners would be willing to wait for work to continue would be influenced by the availability and terms of unemployment or severance pay, availability of other job opportunities, and strength of ties to the community.

Temporary mine shutdowns or reductions in force would have repercussions for other Park County businesses. Service businesses may also lay off employees or curtail services if spending in the county declined due to a mine shutdown or reduction in force.

Extended Life of Mine

The Jardine Joint Venture project could operate for more than 20 years if additional ore reserves of sufficient grade are delineated. Mine employment would be extended and the effect of a permanent closure would be delayed.

Cumulative Impacts

The Forest Service has scheduled several small timber sales in the Gardiner area between 1987 and 1996. It is estimated that each sale would employ at least 5 people. Potential local employment for each harvest is expected to be small--between 3 to 7 jobs each sale (Steve Christianson, U.S. Forest Service, pers. comm., September 18, 1985).

SOCIOLOGY

Demography

The proposed project is expected to employ about 50 workers during the initial construction period and first phase of the mine operation (1986 and 1987). Beginning in 1988, the mine is scheduled for full-time operation and, at that point, the mine and mill would employ about 150 people. Given the added need for services and the available income due to the mine and mill, secondary employment in the county would increase by about 45 persons by 1991.

Table III-17 presents the estimated employment by quarter from beginning construction to full operation employment. This employment schedule was used to estimate the number of persons who would move to Park County due to the project. Ten people currently employed by the Jardine Mining Company at the project site are included in the total mine operations employment.

Population Projections

Estimates of project-induced in-migration were formulated for a low and a high series (see table III-18). The low series was estimated assuming that 20

Table III-17: Project Employment Schedule by Quarter

	1986			1987				1988	
Employment	2nd quarter	3rd quarter	4th quarter	1st quarter	2nd quarter	3rd quarter	4th quarter	1st quarter	2nd quarter
Construction	25	45	25	35	55	25	0	0	0
Mine operation	10	10	10	10	10	10	72	100	150
TOTAL	35	55	35	45	65	35	72	100	150

Source: Mountain International, Inc., 1984, Mitigation Plan, p. 38.

Table III-18: Population and Employment Associated with the Proposed Project--Park County, Montana

Year	Construction employment in-migration Low	Construction employment in-migration High	Mine operation in-migration Low	Mine operation in-migration High	Mine-induced employment in-migration Low	Mine-induced employment in-migration High	Total Low	Total High
1986	15	37	0	0	0	0	15	37
1987	17	44	29	71	0	0	46	115
1988	0	0	36	90	6	9	42	99
1989	0	0	0	0	9	11	9	11
1990	0	0	0	0	0	0	0	0
TOTAL	32	81	65	161	15	20	112	262

Source: Montana Department of State Lands, unpublished working papers, June 1985.

percent of the mine and construction workers would come from outside the county. The high series was estimated assuming that 50 percent of the mine and construction workers would be from outside Park County and Mammoth, Wyoming. Each worker coming into the area was assumed to have 1.3 dependents.

In-migration was also estimated for mine-induced employment growth (secondary or nonbasic jobs). Only mine operations employment was assumed to generate secondary employment because the construction jobs are too short term to induce secondary job creation (Mountain International, Inc., 1984) (see Chapter III--Employment). The low series estimate assumed that for every 5 mine operation jobs, 1 additional service sector job would be created; the high series assumed that 1 service sector job was created for each 3 mine jobs. Both projections lagged secondary job creation one year after mine operation employment increases. Each scenario also assumed that 20 percent of mine-induced secondary jobs would be filled by newcomers to Park County with 1.3 dependents each.

The estimates prepared in table III-18 show that the total in-migrating population due to the proposed project is expected to be between 112 and 262 persons. Assuming that the migration would occur evenly over a 3- to 4-year period and that the average household size is 3.0 persons, there would be approximately 37 to 87 new households locating in Park County the first four years of the proposed project. Expected in-migration would peak in the second year when 15 to 38 households would locate in Park County. It is likely that some of the construction-induced population increase would be temporary, and such workers and their families may leave Park County once the mine is online. If all nonlocal construction workers left Park County when the project is operational, total long-term in-migration would be between 80 to 181 people--or 27 to 60 new households.

The distribution of newcomers to the area would depend on housing availability in the Gardiner/Jardine area and commuting distances to Livingston. Some of the newcomers would settle in the Gardiner area, some in the Upper Yellowstone Valley area, and a smaller portion in Livingston. Because the migration would occur over a three-year period and because the expected number of new people would be small relative to the population base, there should be little change in the demographic environment of the area.

In-migration to the Gardiner/Jardine area would be influenced initially by housing availability and space availability for mobile homes and recreational vehicles (see Chapter II--Housing). Both are limited, so initial population impact in the Gardiner/Jardine area may be below the long-term impact if workers locate closer to the mine and as more housing is built to accommodate such relocation.

Social Life

Social Values. Impacts to social life are based predominantly on information in the Jardine Area Project Socioeconomic Impact Assessment, Volumes I and II, prepared by Mountain International, Inc. (1984).

Residents in the Gardiner area vary both in their perceptions of how the project may affect the area and in the importance they ascribe to these changes. Some residents of the Gardiner area may consider the quality of their lives diminished because of changes that could result from mining activity or from the increased population accompanying the project. The increased population; additional traffic, especially during construction; increased noise at the minesite from mine/mill construction and operation; impacts to the physical environment; and potential social conflict could cause people to perceive changes in the characteristics of the area they value most. Gardiner residents may perceive a deterioration in the quality of the natural environment; a faster pace of life; less friendliness among residents; or a reduction in the quiet, solitude, and privacy presently enjoyed in the area.

Jardine residents would be most likely affected by such changes because of their close proximity to the mine and their strong appreciation of the natural environment; the slow-paced life; the friendliness of neighbors; quiet, solitude, and privacy of the area; and the sparse population of Jardine.

Other residents may consider the quality of their lives improved because of expanded opportunities for employment and increased economic security. Individuals obtaining new employment as a result of the project, their families, and Gardiner area businesses would benefit from these changes.

Social Structure and Interaction. The impact of the project on the social structure and pattern of social interaction in the Gardiner area would be largely a function of the size of the in-migrating population. As the number of people migrating into the area increases, the potential for structural changes in the local social system rises. The process of absorbing in-migrants also may be slowed if the newcomers' histories are significantly different from, or incompatible with, the experiences of local residents.

At the community level, there would be little, if any, adverse impact to the social structure or patterns of social interaction if the following assumptions hold true:

--The company maintains a small workforce (100 to 150 maximum) and hires a significant number (80 percent) of its workforce locally.

--Newcomers' housing is scattered among current residents rather than concentrated in a few locations.

--Local residents are not threatened by newcomers and their lifestyles.

--The newcomers have similar demographic characteristics at the existing community (such as age, education, and marital status), have similar expectations of their community, and are relatively conservative in their personal life.

--The newcomers make a commitment to the local area such as buying homes and taking active interest in community affairs.

Social interaction may become more formal in the Gardiner area as the population increases. Depending on how well newcomers become integrated into the community, this formality may lessen. If newcomers are not integrated, they may form a new separate group and compete for power and status in the community. The social conflict present among local residents could increase if newcomers and locals have different attitudes toward the project.

The proposed project may reduce the importance of outside influences in Gardiner. Although the company would depend on the world market for the sale of its product, Gardiner would remain oriented to Yellowstone National Park, but to a lesser degree.

Economic Life. The seasonality and economic insecurity that characterize the Gardiner area would be reduced and local financial investment would increase if the project is built and operates without interruption. Underemployment of the local population would decrease if the applicant hires the majority of its workforce from Park County. As the income of some local residents increases from direct mine employment or increased business, the relative economic status of other residents would decrease.

Temporary or early plant closure would lessen economic security in the Gardiner area and could cause economic hardship for employees and their families. While some workers might return to former employment, others may not be able to do so. Area businesses that expand requiring increased, long-term business to finance such investment, could face economic hardship as well.

Political Life. The voting and individual political activities of the applicant's employees would have an indirect effect on local political life. The number of additional voters would depend on the number of nonlocal persons hired by the applicant, but would not likely tip local elections. The applicant would petition state and local governments on issues that would directly affect its operations; however, the applicant would not participate in partisan politics at the local level.

Religion. Workers new to the area would exhibit a range of religious beliefs and practices. Some would be sustaining active members of a religious community, others would not. Most likely, newcomers would hold religious beliefs within the large Judeo-Christian tradition which are familiar to area residents.

Social Problems. Anxiety may result from uncertainty about the changes that would occur with development of the mining project. Anxiety would be most probable among people living along the Jardine Road because these residents would be most directly affected by the physical changes caused by the proposed project.

Increases in mental-health, alcohol-treatment, and related caseloads would be very small and would not burden the existing treatment system. Any increase in these problems, however, would be important to the individuals affected and their families.

Residents of the Gardiner area may require the formal provision of services that are now provided informally, such as day care. Informal services in the community may be strained if a greater proportion of the population is employed full time.

The project will have no effect on Park County residents' civil rights. Other than enhanced job opportunities, the project will have no effect on minority groups or women.

Crime could increase in Park County because of the project. There would be occasional incidents involving members of the mine workforce or members of their families of which the community would not approve. These incidents may include activities such as hunting violations or disorderly conduct.

Attitudes and Concerns. Groups concerned with the changes caused by the project include groups comprised of local residents and others with membership statewide and beyond. The introduction to this publication includes a list of public concerns.

Persons interested in the expansion of commercial services or cultural events may view the prospect of population growth in positive terms because an increase in the number of people can help support this expansion. Likewise, those persons interested in maintaining a pristine, natural environment or in the uncompetitive use of recreational resources may view a population increase as harmful. For those concerned about the quality of local schools and other government services, population growth can offer both opportunity and threat.

Mine Closure. Social life after the mine closes would depend on the number of people who leave the area, the demographics of the remaining population, the mix of people in the various social groups, and how well the mine-related population integrated into the community.

Community Services

Impacts to community services that would occur because of the proposed mining project are associated with increased migration into the area. Workers

and their families would move in, establish residences, and exert an increased demand on community services. Predicting the impact of this increased demand, however, depends on knowing the exact numbers of newcomers and where they would settle.

Although it is not known where workers and their families would choose to reside, two factors would likely influence this choice. First is the limited number of houses, trailer parks, and homesites in the Gardiner/ Jardine area. Second, there is a high monetary cost associated with securing a residence in this area. These factors would encourage settlement to the north in Corwin Springs, the Upper Yellowstone Valley, and Livingston (Andy Epple, Park County planner, pers. comm., May 3, 1985).

Unless existing housing is replaced by multi-family units, most newcomers would probably not settle in the Gardiner/Jardine area; therefore, impacts on community services would be reduced. The Upper Yellowstone Valley (Mill Creek, Emigrant, and Point of Rocks) has numerous undeveloped tracts available and Livingston has plenty of reasonably priced homes on the market. Community services for both the Upper Yellowstone Valley and Livingston are adequate to accommodate modest population increases in excess of what would be contributed by the project.

Law Enforcement. The Park County sheriff's department would be affected by the proposed project because of increased demands for law enforcement services. Increased traffic, vehicle accidents, and increased crime would aggravate the workload of existing deputies and could necessitate hiring additional staff.

The Park County sheriff and Park County citizens believe that an additional deputy would be needed after the mine opened. (Bob Oakland, Park County sheriff, pers. comm., April 1985). The sheriff, as well as other Gardiner residents believe that the deputies are often overworked and unavailable in Gardiner when needed, and that two more deputies are needed--one even without the proposed project (Gordon LeFever, member, former Park County Planning Advisory Group; Dave Schreiber, member, Gardiner Concerned Citizens; Gardiner Chamber of Commerce, all pers. comm., April 1985).

Additional law enforcement problems in the Gardiner area could result with an influx of transients in search of employment. New developments, such as the proposed mine/mill complex, often attract unemployed persons who may commit crimes (Mountain International, Inc., 1984, Mitigation Plan, p. 92).

Crime in Park County would increase with the proposed project. Even if the company were able to hire 80 percent of the workforce locally, criminal homicide, forcible rape, robbery, aggravated assault, burglary, larceny-theft, motor vehicle theft, and arson could be expected to increase (Bob Oakland, Park County sheriff, pers. comm., April 1985).

Increased commuter traffic on U.S. 89 as a result of the project would require additional law enforcement activities by the Montana Highway Patrol. During full employment years, mine-related traffic is projected to account for 8.3 to 12.3 percent of all traffic on U.S. 89. The number of accidents would increase an average of 7 per year (see Transportation, table III-24).

Education. The Livingston schools could accommodate the projected increase in enrollment due to the proposed project. The schools may experience a small increase in the budgets for instructional supplies, but little else would be affected (Mountain International, Inc., 1984, Mitigation Plan, p. 85).

The rural schools of Richland and Arrowhead are presently operating below capacity; therefore, enrollment increases would not seriously affect the school districts (Sonja Spannring, Park County Superintendent of Schools, pers. comm., May 1985).

The Gardiner residents presently enjoy what they consider a good-quality education for their children. This feeling is based primarily on the low student/teacher ratio (presently a low of 8 students/teacher and a high of 16 students/teacher). If the ratio were to exceed 23 students per teacher, the community would consider this increase unacceptable. However, if the enrollment projection is correct, the students coming into the district are not all one age, and if the Mammoth School does not close, the Gardiner School could absorb the projected number of in-migrating students and still maintain the present quality of education (Lynn Mavencamp, superintendent, Gardiner Public School, pers. comm., April 1985).

Fire Protection. The Livingston and Gardiner fire departments are adequately staffed and equipped to provide fire protection for newcomers. Residential developments in rural areas would receive fire protection from volunteers of the five rural fire districts.

The need for fire protection in the Jardine area would be increased with the mine/mill complex and the construction of new residences. The suppression of fires in mines requires skills and specialized equipment that the Gardiner fire department does not possess. In addition, the mobilization and travel time to move firefighters and equipment from Gardiner to Jardine is 15 to 20 minutes with good road and weather conditions--an unacceptably long time for "first line" fire protection (Mountain International, Inc., 1984, Mitigation Plan, p. 96).

The applicant has agreed to provide fire protection at the plant and to negotiate a contract with the Gardiner fire department to provide back-up fire protection.

The residents of Jardine, who are not presently in a fire district, would not be covered in the contract between the applicant and the Gardiner Fire Department (Carlo Cieri, Park County Commissioner, pers. comm., May 1985; Gene Kremer, Gardiner volunteer firefighter, pers. comm., April 1985). With additional risks of fire to the Jardine residents' homes because of the possibility of mill fires, the need for fire protection would become more critical with the project.

The Gardiner Fire District could extend its boundaries to include Jardine homes within the district. Such property would be taxed to provide funding for the increased service area (Mountain International, Inc., 1984, Mitigation Plan, p. 97). However, this alternative may not provide sufficient fire

protection to Jardine homes given the 15- to 20-minute response time from Gardiner. Equipment and volunteer firemen may need to be located closer to Jardine to provide adequate protection.

Ambulance. The applicant has agreed to provide an ambulance and certified emergency personnel at the mine site and would contract with the Gardiner volunteer ambulance service for support service. Therefore, no significant impacts are expected on existing emergency medical services in Gardiner.

More traffic accidents are expected to occur on U.S. 89 due to increased commuter traffic. The Livingston ambulance service (Community Lifeline) would be able to service this increase in emergency situations.

Hospital and Medical Personnel. The Livingston Memorial Hospital would experience a slight increase in the number of admissions primarily due to traffic- and mine/mill-related accidents. The hospital has adequate facilities and staff to meet this increased need for health services.

Accidents at the mine/mill complex and increases in highway accidents would require additional care by local Park County physicians. Existing facilities and physicians are adequate to accommodate expected demands for medical services.

Water Supply. Increased water demand associated with the mine/mill complex and new residences would have no adverse impact on municipal water supplies. Livingston and Gardiner are currently constructing new wells to ensure adequate water supplies for expanding domestic and industrial use as well as for fire protection.

Wastewater Treatment. There would be little impact on the existing Gardiner wastewater treatment facility because of the limited number of projected new residences in Gardiner. At or near the mine site, however, the mine/mill complex and the projected number of residences would create a need for disposal of wastewater (Olin Hart, Homestake Mining Company geologist, pers. comm., April 1985). A detailed engineering study would need to be conducted to determine the feasibility of installing a septic tank system (Roy Wells, Water Quality Bureau, Montana Department of Health and Environmental Sciences, pers. comm., May 1985).

Settlement in the Upper Yellowstone Valley would not exert demand on existing water treatment facilities because rural developments rely on septic tank disposal of wastewater. The burden of providing such treatment would be on the landowner and would not affect public treatment facilities.

The Livingston wastewater treatment facility is operating at below capacity. There is no expected impact by incoming workers and their families.

Solid Waste. There would be no significant impact for solid waste pick up and incineration except possibly at Jardine. Additional solid waste would be generated at the mine/mill complex and at residences of incoming mine/mill workers in Jardine. The disposal of the solid waste could pose a problem because without regular disposal and construction of chain link fences around collection bins, refuse would become an attraction for scavenging bears (Ed

Flatt, operator/manager, Park County Incinerator, pers. comm., May 1985). The incinerator at Livingston is operating well below capacity and economic advantages would be realized if larger amounts could be burned to help defray the per-unit cost of the facility.

Social Welfare. Transient job seekers moving to Park County in search of work in the mine may increase the number of persons on welfare. Because the State of Montana has assumed the responsibility of the county welfare program, additional welfare costs would not adversely affect the Park County residents. Under the existing state system, a maximum 13.5 mill poor fund levy is assessed against taxable property (Mountain International, Inc., 1984, vol. II, p. 89). If the poor fund revenues do not sufficiently cover social welfare costs, the state pays the difference.

Housing. Due to the limited housing (i.e., homes for sale, rental units, trailer courts) in the Gardiner/Jardine area, the existing market would be saturated by mine/mill workers and additional housing would need to be secured in rural areas between Gardiner and Livingston or in Livingston.

The number of housing units that would be required to accommodate permanent mine/mill workers and families would range from 30 to 75, depending on the number of non-local workers that would be hired (Mountain International, Inc., 1984, Mitigation Plan, p. 58). Considering the number of housing units and/or building sites available within commuting distance of the mine site, the influx of population as a result of the project would not unduly stress the market.

Increased demands for housing in the Gardiner area as a result of the project probably would increase rental rates, lot prices, and house prices (Andy Epple, Park County Planner, pers. comm., May 3, 1985). Such increases would raise living costs for seasonal tourist industry employees and others. However, if developers build more houses, such increases will not occur. Competition from mine employees would render housing less available on a seasonal basis for the temporary workforce.

Except for possible housing availability and cost issues, consumers in Park County would not be adversely affected by the project.

Mitigating Measures

--The applicant could negotiate an agreement with the Gardiner fire department to provide first-call fire suppression to Jardine residences with backup from the Gardiner fire department. It may be necessary to form a fire district or other legal organization that allows Jardine area residences to be included in such an agreement.

--The applicant has agreed to confer with the Montana Department of Fish, Wildlife and Parks and the U.S. Forest Service to ensure that temporary garbage facilities are bear proof (project application, 1984, vol. IV-1, p. 16). Fencing and bear-proof garbage cans are examples of equipment that would keep bears out of garbage.

FISCAL

Summary. The JJV project would increase tax revenues for Park County, both school Districts in Gardiner, special service districts in Gardiner, and the state of Montana. Over the life of the project, and at current gold prices ($316.47 per ounce), the applicant would add between $986,000 and $2.6 million to the annual tax base of the Park County and both Gardiner school districts. The service districts in Gardiner would receive between $634 and $4,320 dollars in increased revenues at current rates for services, assuming that incoming workers build 15 new homes within the service district boundaries. The state would receive $301,570 annually from the mine at current gold prices.

Park County and Gardiner School Districts

Local property tax values would increase directly and indirectly due to the project. Direct increases accrue from capital improvements and equipment purchases made by the applicant and from the taxable value of the gold production by the project. Indirect tax increases occur due to persons moving to the county to take mining jobs. These persons may build homes and will acquire other taxable property.

Table III-19 shows the taxable value of the gold production from the Jardine Mine at various gold prices. Three percent of the gross value of the gold produced (gross proceeds) is taxable as Class II property. It is assumed that the applicant would produce 49,100 ounces of gold annually at full production. At such production rates and at current market prices for gold ($316.47 per ounce, May, 1985), $466,160 would be added annually to the tax base of Park County and both Gardiner school districts.

Table III-20 shows the expected total annual increase in taxable value due to the project. The taxable value would fluctuate as the project acquires new equipment and other capital improvements and as the value of such improvements depreciates. In 6 of the 23 years, the increase in taxable valuation would be greater than $2 million of the fiscal year 1985-1986 (FY85) taxable valuation. In all other years except the final year, taxable valuation of the project would be over $1 million. The taxable valuation of the project would be influenced by the price of gold, and would vary from the values shown in table III-20 as the price of gold fluctuates.

Park County would also receive property tax revenues due to new mine workers locating in the county. Such indirect increases could range from $61,000 to $155,000 annually (Mountain International, Inc., vol. 11, p. 135).

Table III-19: Annual Taxable Value of Gross Proceeds at Various Prices of Gold[1]

Price per ounce of gold[2]	Gross value	Taxable valuation[3]
$250.00	$12,275,000	$368,250
300.00	14,730,000	441,900
316.47	15,538,677	466,160
350.00	17,185,000	515,550
400.00	19,640,000	589,200
450.00	22,095,000	662,850
500.00	24,550,000	736,500
750.00	36,825,000	1,104,750

[1]Annual average gold production would be 49,100 ounces (Mountain International, vol. 2, 1984, p. 133).

[2]The weekly average price of gold at the London market was $316.47 per ounce for the week ended May 3, 1985 as listed in Metals Week, May 6, 1985, p. 4. It is not known at what gold prices the project would be profitable.

[3]Gross proceeds taxable value is 3 percent of gross value.

Table III-20: Estimated Annual Taxable Value of the Project by Fiscal Year

Fiscal year	Capital investment[1]	Gross proceeds[2]	Total
1987	$ 846,450	$233,080	$1,079,530
1988	736,865	466,160	1,203,025
1989	653,605	466,160	1,119,765
1990	1,645,500	466,160	2,111,660
1991	1,517,861	466,160	1,984,021
1992	1,417,765	466,160	1,883,925
1993	1,281,041	466,160	1,747,201
1994	1,149,008	466,160	1,615,168
1995	2,096,260	466,160	2,562,420
1996	1,841,107	466,160	2,307,267
1997	1,667,885	466,160	2,134,045
1998	1,491,899	466,160	1,958,059
1999	1,359,824	466,160	1,825,984
2000	1,230,500	466,160	1,696,660
2001	1,102,862	466,160	1,569,022
2002	1,002,767	466,160	1,468,927
2003	1,942,659	466.160	2,408,819
2004	1,683,070	466,160	2,149,230
2005	1,480,620	466,160	1,946,780
2006	1,293,094	466,160	1,759,254
2007	1,243,581	466,160	1,709,741
2008	1,097,484	313,881	1,411,365
2009	985,994	-0-	985,994

[1]Source: Mountain International, 1984, vol. 2, p. 134.

[2]The price of gold is assumed to be $316.47 per ounce with an annual production of 49,100 during full operation.

Gardiner Special District Revenues and Costs

Special district revenues and costs would depend on the number of mine workers and their families who settle in Gardiner. None of the districts would need to undertake capital expansions or add staff in order to maintain existing service levels and extend service to newcomers (Mountain International, 1984, vol. 11, p. 155) (see also Chapter III--Community Services).

Table III-21 shows projected costs and revenues for the Gardiner water, sewer, and fire districts assuming that 96 people move to the Gardiner area due to the project. Only increases in variable costs are shown because fixed costs are already being recouped by the districts. Variable costs are also the most sensitive to changes in population.

The water district would experience revenue surpluses, which would begin to decline in FY91. As revenues from new residents stabilize and variable costs increase, the district may need to raise water charges in order to cover costs (Mountain International, 1984, vol. 2, p.157).

The sewer district would have a deficit the first year of the project. However, revenues (property taxes and service fees) are projected to cover service costs for the remainder of the forecast period, if an estimated 15 new homes were constructed.

Table III-21: Projected Revenues and Expenditures for the Gardiner Water, Sewer, and Fire Districts

	FY86	FY87	FY88	FY89	FY90	FY91
Water district						
Projected increase in revenue[1]	$2,592	$3,600	$4,320	$4,320	$4,320	$4,320
Projected increase in variable costs[1]	674	1,425	1,871	2,026	2,194	2,352
Surplus or (deficit)	$1,918	$2,175	$2,449	$2,294	$2,126	$1,968
Sewer district						
Projected increase in revenue[2]	$ -0-	$ 962	$1,924	$2,886	$2,886	$2,886
Projected increase in variable costs[2]	134	282	371	402	436	467
Surplus or (deficit)	$ (134)	$ 680	$1,553	$2,484	$2,450	$2,491
Fire district						
Projected increase in revenue[3]	$ -0-	$ 634	$1,268	$1,903	$1,903	$1,903
Projected increase in variable costs[3]	96	200	257	273	289	304
Surplus or (deficit)	$ (96)	$ 434	$1,011	$1,630	$1,614	$1,599

Source: Mountain International, Inc., 1984, vol. 1, p. 156.

[1]Based on average household water fee of $12.00 per month. Variable costs set at $14.02 per capita and escalated 8.3 percent per year.

[2]Based on current mill levy at 75 mills applied to taxable value of estimated 15 new homes. Variable costs set at $2.78 per capita and escalated at 8.3 percent per year.

[3]Based on current mill levy of 49.45 mills applied to taxable value of estimated 15 new homes. Variable costs set at $2.09 per capita and increased 6.1 percent per year.

The fire district would also have a deficit the first year of project operation. If 15 new homes were built in the Gardiner area, the district would be able to generate revenues in excess of costs through FY91.

Park County Solid Waste District

The Park County solid waste district can accommodate increased use without adding additional staff or increasing capital expense (Mountain International, Inc., vol. 2, p. 159). Table III-22 shows projected revenues and costs for the district.

The projections are given for a high and low population growth associated with the project. The low-impact scenario assumes 20 percent nonlocal hire, while the high scenario assumes 50 percent nonlocal hire. In both instances surplus revenues are generated that peak in FY89. The greater the number of nonlocal persons hired by the applicant, the higher the surplus revenues would be.

If revenues were to continue to decline after FY91 and costs continued to increase, the district could raise collection fees. If necessary, the district could also levy property taxes (Mountain International, Inc., 1984, vol. 2, p. 158).

State Revenues

The state would receive two revenues from the proposed project--the metal mines license fee, and Resource Indemnity Trust taxes (RIT). Both are based on the gross value of mineral production. The metal mines license tax is graduated with taxation rates on the gross value of production of 1) 0.5

Table III-22: Estimated Revenues and Costs for the Park County Solid Waste District FY87 to FY91 (1980 dollars)

Scenario	FY86	FY87	FY88	FY89	FY90	FY91
20 Percent nonlocal hire						
Projected increase in revenue[1]	$546	$1,066	$1,292	$1,292	$1,292	$1,292
Projected increase in variable costs[2]	123	259	337	363	389	414
Surplus or (deficit)	$423	$ 807	$ 955	$ 929	$ 903	$ 865
50 Percent nonlocal hire						
Projected increase in revenue[1]	$546	$1,532	$2,158	$2,158	$2,158	$2,138
Projected increase in variable costs[2]	123	372	563	606	650	691
Surplus or (deficit)	$423	$1,160	$1,595	$1,552	$1,508	$1,447

Source: Mountain International, Inc., 1984, vol. 2, p. 158.

[1] Revenues are based on $15.00 per ton tipping fee. Additional revenues are possible through property taxes, if necessary.

[2] Costs are based on variable cost of $2.93 per ton escalated at 7.5 percent per year.

percent of the amount between $250,000 and $500,000, 2) 1.0 percent of the amount between $500,000 and $1 million, and 3) 1.5 percent of the amount in excess of $1 million. The RIT is 0.5 percent of the gross value in excess of $5,000 or $25 for mines producing up to $5,000 worth of minerals.

Table III-23 shows annual tax revenues generated by the project at selected prices of gold at full production (49,100 ounces per year). At recent gold prices ($316 per ounce), the project would contribute $301,570 annually at full production to the state. Over the life of the project, assuming a price of gold at $316 per ounce, the mine would pay $4.77 million in metal mines license fees and $1.64 million in RIT.

Mitigating Measures Hard Rock Mining Impact Mitigation Plan

--Developers of large-scale hard rock miners or associated milling facilities are required by law to prepare a fiscal impact plan describing the impacts that a proposed development will have on units of affected local government (90-6-307, MCA). The plan will include the estimated number of persons expected to come into the affected area, the increased capital and operating costs to units of local government, and the financial or other assistance that the developer will provide to such governments (90-6-307[1], MCA). Developers are required to pay all increased capital and net operating costs to affected local government units (90-6-307[2], MCA).

--State law also contains tax-base-sharing provisions designed to distribute tax revenue among counties, municipalities, and school districts according to the number of mineral development employees living within the jurisdiction. Municipalities may receive a portion of the taxable value not to exceed 20 percent; such portion is to be distributed among

Table III-23: Annual Jardine Joint Venture Project Tax Revenues at Selected Gold Prices

Price of gold per ounce[1]	Gross value (millions)	Metal mines license tax	Resource indemnity trust tax	Total
$250	$12.275	$175,425	$61,375	$236,800
300	14.730	212,200	73,650	285,850
316	15.516	223,990	77,580	301,570
350	17.185	249,025	85,925	334,950
400	19.640	285,850	98,200	384,050
450	22.095	322,675	110,475	433,150
500	24.550	359,500	122,750	482,250
750	36.825	543,625	184,125	727,750

Source: Mountain International, Inc., vol. 2, p. 149 and Department of State Lands.

[1]The break-even or profitable price of gold for the project is not known. The May 1985 gold price was $316.47 per ounce (Metals Week, May 6, 195, p. 4).

municipalities according to the percentage of the total number of mineral development employees living in each municipality. The remaining portion of taxable value must be distributed among each affected county according to the percentage of mineral employees living in each county. High school and elementary districts receive a pro-rata share of the taxable valuation of the hard rock mine according to the percentage of the total number of mineral development students living in each district (90-6-404, MCA).

--The applicant prepared an impact plan that was accepted by Park County. The plan analyzed the potential for impacts to Park County, Gardiner school districts #4 and #7, the Gardiner water and sewer districts, the Gardiner fire district, and the Park County Refuse Disposal District. The city of Livingston and Paradise Valley were not included in the impact plan document analysis; estimated population increases in these areas are not expected to cause projected service cost increases above associated revenues (Mountain International, Inc., 1984, Impact Plan, pp. 16-17).

--The company would provide total assistance of $526,000 to Park County in the form of tax prepayments. The applicant would provide $15,000 to the sheriff's department for communication or other equipment and $500,000 to upgrade the Jardine Road. The applicant would negotiate contracts with the Gardiner ambulance and the Gardiner fire district to provide back-up service at the project site. The fixed annual fees would be negotiated (Mountain International, Inc., 1984, Mitigation Plan, pp. 61, 98, and 123).

--Grants and loans from the hard-rock mining impact trust account are available to units of local government when a mining operation has permanently ceased operations or has reduced its full-time equivalent mining work force by 50 percent over the preceding 5-year period (90-6-321[1], MCA). (See Chapter III--Fiscal Conditions.) The Hard-Rock Impact Board may award grants and loans to pay for outstanding capital project expenses, to decrease unusually high property tax revenues, and to promote development of new industry or new employment opportunities in the area (90-6-321[2], MCA).

LAND USE

Summary. Land use would not change substantially in Park County due to the project. Reclamation of surface disturbance within the permit area would be planned so as to establish suitable wildlife habitat and livestock grazing land after mine closure (see Chapter III--Vegetation). Within Park County, up to 19 acres of agricultural land could be converted to residential uses if incoming mine workers chose to construct new homes.

Direct Land Use Impacts

The surface disturbance associated with the tailings and waste rock dump would destroy 67 acres of native vegetation and 26 acres of previously disturbed land. Reclamation of disturbed areas would eventually provide suitable wildlife browse, habitat, and livestock grazing land (see Chapter III--Vegetation and Wildlife).

Conflicts between mining land uses and recreational land use in the Jardine area should be minimal. Mining traffic on the Jardine Road may interfere with recreational sightseers and with hunters. Mining may also cause elk and deer to avoid historic habitat until they are accustomed to the increased noise and activity. Such habituation may take 3 to 5 years, but would not cause significant impacts to the late-season elk hunt (see Chapter III--Wildlife and Transportation).

Indirect Impacts

Indirect land use impacts would occur due to people moving into Park County to take mining jobs and subsequently build new homes. Conversion of agricultural land to residential uses would depend on the number of nonlocal employees hired by the applicant and the housing preferences of such employees.

Between 7.5 and 19 acres of agricultural land could be converted to residential uses. Such figures assume that each residence uses 0.25 acres, that there are 30 to 75 nonlocal employees who are hired by the project, and that each builds a new home.

TRANSPORTATION

Summary: The mine and mill would cause significant increases in average daily traffic (ADT) levels on the Jardine Road, but only moderate increases on U.S. 89. During the first year of full-employment operation, traffic would increase 50 to 70 percent on the Jardine Road, and about 12 percent on U.S. 89. Accidents would increase by almost one-fourth on U.S. 89.

Cumulative impacts on the Jardine Road and U.S. 89 due to proposed timber sales will be negligible. Two sales are planned for 1989 to 1994. The first sale would generate six additional vehicles per day on each road and the second would add about four vehicles per day.

Project Traffic. Transportation impacts from the proposed project would come from three sources--employees commuting to work, supply and ore trucks traveling to and from the mine, and newcomers traveling from home to work or other household supply trips. The transportation impacts would affect U.S. 89 and the Jardine Road. Mine-related traffic would increase and reach a plateau when the mine and mill are in full operation in 1988, year 3 of the project.

Table III-24 shows the number of project employees by shift for Monday through Friday. Weekend project staffing would consist of a mill crew and security (Mountain International Inc., 1984, Impact Statement, p. 118). A total of 138 workers would commute to the mine and mill each weekday. The incremental traffic increase due to commuting employees would depend on the willingness of workers to carpool. The applicant would require management personnel to participate in a drive, park, and carpool program from Gardiner to the minesite in order to reduce traffic on the Jardine Road.

A second source of traffic increases related to the mine would come from household supply trips to Gardiner or Livingston; a trip to the grocery store is an example. The number of mine-related household trips generated would depend on the number of nonlocal people hired by the applicant, the number of newcomers who choose to reside in Gardiner or south of Livingston, and the number of local workers who relocate closer to the minesite in Gardiner or south of Livingston.

The third source of traffic generated by the mine would include vehicles driving to and from the mine with supplies and ore. Supply truck trips would peak in 1987 during mine construction and would taper off to 5 to 10 round trips per day after the mine is on line (Mountain International, Inc., 1984, Impact Plan, p. 71). There would be two ore trucks traveling to and from the mine daily.

U.S. 89

Table III-25 shows the projected average daily traffic (ADT) and accidents on U.S. 89 due to the project, and the percentage increase above projected ADT and accident levels without the mine. Project-related traffic and accident increases are based on an extreme case of worker location assumptions. It was assumed that 15 workers and their families would locate in Gardiner with the balance of the workforce locating in Livingston. Commuting patterns were based on the shift schedule in table III-24 and it was assumed

Table III-24: Weekday Distribution of Workforce by Shift[1]

Work category	First shift	Second shift	Third shift	Total[2]
Administrative/laboratory/clerical	24	2	2	28
Mill operations	5	5	5	15
Maintenance/shops	20	0	0	20
Underground workforce	38	37	0	75
TOTAL	87	44	7	138

Source: Mountain International, Inc., 1984, Impact Plan, p. 69.

[1] This table represents a five-day workweek. The mine would operate 5 days per week, while the mill would operate 7 days per week.

[2] The total does not include mill workers and security guards who would work weekend shifts.

Table III-25: Estimated Traffic and Accident Increases Due to the Project[1]

Year	Projected average daily traffic[2]			Estimated number of accidents[3]		
	Without project	Added by project	Percent increase	Without project	Added by project	Percent increase
1988[4]	1,080	133	12.3	51	7	13.7
1990	1,132	133	11.7	57	7	12.3
1995	1,273	133	10.4	64	7	10.9
2000	1,432	133	9.3	72	7	9.7
2004	1,611	133	8.3	81	7	8.6
TOTAL FOR PERIOD OF FULL EMPLOYMENT[5]	NA	NA	NA	452	114	25.2

Source: Department of State Lands, unpublished working papers, June 1985.

[1]See table II-44 for development of estimates of traffic accidents and fatalities without project.

[2]The ADT with-project estimates assume that 15 employees locate in Gardiner and the balance would locate in Livingston, which would produce an ADT representative of extreme conditions. Worker/commuter traffic patterns were calculated according to the shift schedule outlined in table III-24.

[3]The with-project accident estimate used the statewide rate of 2.67 accidents per million miles driven (1977-1982).

[4]Full employment for the project would last from 1988 to 2005.

[5]Totals include each year of the forecast period and will be larger than the sum of each forecast point.

NA means not applicable.

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that workers carpooled with two persons per vehicle. Household trips were estimated to be six round trips to Livingston per project worker household each week. The number of mine-supply trips was assumed to be 10 daily round trips per week and the number of ore truck round trips was assumed to be 1 daily per week.

Mine-related average daily traffic (ADT) on U.S. 89 would produce a 12.3 percent increase above projected ADT without the mine during the first year of operation. Project-related traffic would account for a decreasing percentage of daily traffic on U.S. 89 throughout the life of the mine due to expected growth in traffic without the mine. During 2005, the final full year of mine employment, project-related traffic would produce an additional 8.3 percent daily traffic. These traffic increases represent extreme case conditions. Actual traffic increases on U.S. 89 would be lower if mine worker vehicles carry more than two people per car.

Project-related traffic increases would be estimated to cause an additional 114 accidents over the full employment period of the mine life (see table III-25). Accidents were estimated using the statewide rate of 2.67 per

million vehicle miles driven, which is higher than the average for U.S. 89 south of Livingston. These estimates may overstate actual accidents once the project is on line, if accident rates on U.S. 89 remain lower than 2.67 accidents per million vehicle miles driven. However, traffic increases can contribute to higher accident rates, so the higher statewide rate was used in estimating accidents.

Project-related traffic should not cause a significant number of highway fatalities. An increase of two fatalities over the life of the mine is estimated to occur, using the 1972 to 1982 rate on U.S. 89 of 4.27 fatalities per one hundred million miles driven.

Jardine Road

The number of vehicles traveling the Jardine Road could increase by 124 to 166 per day. The low estimate assumes that two workers per vehicle commute, according to the shift schedule in table III-24. It also assumes that there will be 10 round trips daily each week for mine supplies, and one round trip daily for ore trucks. Mine workers relocating to Gardiner also may travel the Jardine Road for recreational purposes; however, such use was not estimated.

The high estimate of traffic increases along the Jardine Road was prepared by Mountain International, Inc., a consultant to the project. By the time the mine is at full production, traffic is estimated to increase 166 cars per day (Mountain International, Inc., 1984, Impact Plan, p. 71). This projection was based on 5 to 10 daily round-trip truckloads of mine supplies and other miscellaneous supplies. Other variables, including the number of household supply trips and worker commute trips, were not specified.

Determining impacts from projected traffic increases on the Jardine Road is difficult. Only one traffic count has been made within the last five years, and the count may overstate ADT on the Jardine Road (see Chapter II--Transportation). The count estimated an ADT of 233 vehicles per day in 1982 (Peccia and Associates, Inc., 1983, Park County High-Hazard Site Locations). If 233 ADT is considered an upper bound for Jardine Road traffic, the minimum traffic increase related to the project could range between 53 and 71 percent over the 1982 level.

Mine-related traffic increases would be particularly troublesome during periods of intense recreational use of the Jardine Road. The late-season elk hunt is noted for heavy traffic congestion along the Jardine Road (Doug Widmayer, Peccia and Associates, Inc., pers. comm., May 29, 1985).

Mitigating Measures

--The applicant will require management personnel to carpool from Gardiner to the minesite (Mountain International, Inc., 1984, Impact Plan, p. 75), but such a restriction will not lower traffic increases on U.S. 89 significantly. Requiring or encouraging all employees who live north of Gardiner to carpool would significantly reduce mine-induced traffic.

--Several steps could be taken to lower projected increases in traffic and accidents on U.S. 89 due to the proposed project. A bus or van service from Livingston to the minesite could be offered to commuting workers. The company could provide such service or underwrite the cost of a privately sponsored bus service. Depending on the capacity of the bus or van and ridership, project-related traffic could be significantly reduced.

--The company could provide financial incentives to employees who participate in carpools. For example, travel allowances, compensation based on mileage, and purchase discounts on fuel from company supplies could be structured to reward workers who travel to work in carpools (Mountain International, Inc., 1984, Impact Plan, pp. 73 and 75). If such incentives were given to employees who carpool with three persons to a car, projected traffic increases could be reduced by one third.

--The applicant has agreed to pay $500,000 to Park County to upgrade the Jardine Road. Improvements to be made include widening the road in several locations, constructing guard rails, and posting more and better warning signs (Mountain International, Inc., 1984, Impact Mitigation Plan).

--The applicant could provide a shuttle service for employees from Gardiner to the minesite, and require employees to use the shuttle service or all personnel could be required to drive to, park in, and carpool from Gardiner. Reducing worker-commuting traffic on the Jardine Road would significantly reduce mine-related traffic increases--particularly during periods of heavy recreational use of the Jardine Road. Requiring employees to carpool from Gardiner could have the added advantage of encouraging such ridership patterns from the point of origin. Project-induced traffic increases on U.S. 89 could be reduced as well.

Cumulative Impacts

There will be minimal increases in average daily traffic on the Jardine Road and U.S. 89 due to timber sales planned by the U.S. Forest Service from 1987 through 1996.

RECREATION

Summary. The project would have little direct impact on National Forest recreation areas.

Secondary impacts from the project could include increased use of the National Forest due to newcomers in the project area. The project estimates a workforce of 150 employees; the local population is projected to fill 120 of these jobs, with 30 new workers coming into the area. The movement of locals into project jobs would probably create other job opportunities that would be filled by new workers to the area. The addition of 150 new workers would no doubt increase recreation use in the National Forest surrounding the project.

However, compared to present and projected numbers of recreation visitors, the impact would be quite small. In addition, most camping in the past occurred at Eagle Creek campground; no changes from this pattern are expected. The increased demand on National Forest-area campgrounds could be accommodated.

The National Forest near the project area is key winter big game range. To prevent harassment of game while on the winter range, the Forest Service has adopted travel restrictions for motor vehicles. With an increased local population, restrictions on non-motorized use may also be needed to prevent harassment of big game.

CULTURAL RESOURCES

Summary. This project would cause 21 structures in the proposed Jardine Historical District to be removed. Figure II-28 details the existing structures in Jardine. Three of these structures are considered significant historic buildings, although they are in poor condition.

The applicant would construct a new road into the project area. The road would cross Bear Creek downstream from the present bridge, requiring construction of a new bridge. The new road would enter the proposed Jardine Historic District (see figure II-28 and table II-47) west of the guest house (Structure 67). Five structures within the historic district would be removed: a frame and metal garage in fair condition (Structure 62), one log house in fair condition (Structure 63), two log houses in poor condition (Structures 64 and 65), and a mobile home in good condition (Structure 68). Four of these structures (Structure 62 through Structure 65) are considered contributing structures within the historic district; the mobile home is an "intrusive" structure.

In addition to the structures removed by the road relocation, a number of buildings would be destroyed within the permit area. Structures associated with the original portal would be removed to facilitate opening a new portal. The frame compressor house (Structure 41) and frame blacksmith shop (Structure 41) are considered significant historic structures, but are in poor condition. The tram control house (Structure 40), a frame outhouse (Structure 45), two frame shacks (Structure 46 and Structure 47), a frame and metal office (Structure 49), and a frame "dry house" (Structure 50) are all contributing structures in either poor or very poor condition.

Construction of the shop and warehouse would remove the frame and concrete powerhouse (Structure 39), a contributing structure in good condition. The laboratory and mill would displace four structures: wooden fly-wheels (Feature 51), a wooden sluice box (Feature 52), miscellaneous frame structures (Feature 53), and a frame electric substation (Structure 54). All are in poor condition. The substation is a significant historic structure and the others are all contributing structures. A collection of concrete foundations (Structure 35) in poor condition would be covered by the proposed ore

stockpile. A frame assay office (Structure 58) and wooden cyanide vats (Structure 61), both contributing structures in poor condition, would be removed during construction of the parking area.

The arsenic plant (Structure 59) is a significant historic structure located outside the anticipated impact area. The company plans to remove the building because it is considered a health hazard. The site was submitted for addition to the Environmental Protection Agency's Emergency and Remedial Response Information System list in 1979 because it may contain hazardous waste materials (Sara Weinstock, Montana Solid and Hazardous Waste Bureau, pers. comm., May 14, 1985). The arsenic plant is in poor condition and contains arsenic-laden materials.

All other structures in the area would not be directly affected by the operation. However, increases in vehicle traffic and the number of people could physically degrade buildings, either inadvertently in the case of an accident, or purposefully in the case of vandalism or souvenir collecting.

Mitigating Measures

Chapter IV of this draft EIS discusses the project's mine access road and the preferred alternative, the location of which could reduce impacts to the historic district in Jardine.

- --The applicant, in consultation with the Montana Department of State Lands and the Montana Historic Preservation Office, could develop a mitigation plan for the Jardine Historic District. This plan could, at a minimum, include a document that notes all significant buildings according to Historic American Building Survey standards, and a report on the district containing an overview of history, detailed description of all structures, and a mapping of the district showing the relationship of buildings.

- --The applicant could reuse some of the existing structures. The guest house (Structure 67), the mine office (Structure 73), and the schoolhouse (Structure 77) could be rehabilitated for use as offices or storage facilities.

- --The new laboratory, mill, and associated facilities could be grouped as closely together as possible. Their location could be shifted to prevent destruction of the wooden fly wheels (Feature 51), wooden sluice box (Feature 52), several frame structures (Feature 53), and a frame electric substation (Structure 54). All are in poor condition, but the substation is considered a significant structure. Perhaps the frame and concrete powerhouse (Structure 39) could be incorporated into the new warehouse rather than be demolished.

- --The applicant could close all buildings on the permit area to unauthorized personnel to lessen the potential for vandalism.

AESTHETICS

Summary. Although the Jardine area has been disturbed by previous mining, the applicant's project would be highly visible to local residents and visitors traveling to Jardine and upstream Bear Creek. The milling building, crushing facilities, and tailings pond would be the most evident features.

Due to the surrounding hills, the operation would only be visible from within 1.2 miles when approaching Jardine on the county road. The operation would also be visible in the background from some areas of Yellowstone Park--Mammoth terraces and Yellowstone lodge, for example.

After mining is complete, all structures would be removed and all disturbed areas revegetated. The tailings impoundment would probably still be recognizable as differing from the surrounding landscape.

During the 18-month construction period for the mine and related facilities, noise levels would increase in the Jardine area. Heavy equipment would be the major noise source. Assuming that construction would occur only during daylight hours, the noise would not be a serious annoyance to most local residents.

During operation of the mine, noise levels would increase substantially near the mill. Noise levels at 10 feet from the mill should be about 89 decibels (dB[A]), assuming the building attenuated about 12.1 dB(A) of the inside noise (on file report, DSL April 15, 1985). Because noise levels decrease at about 6 dB(A) for every doubling of distance from the source (Loucks, 1973), noise levels would approach background levels at about 1/4 mile from the mill. Noise levels at various distances are shown in table III-26. These noise levels would be maintained throughout the day and night since the mill would be in continuous operation.

Table III-26: Noise Levels at Various Distances from the Mill

Distance from mill (feet)	Noise level (decibels)
10	89
20	83
40	77
80	71
160	65
320	59
640	53
1,280	46

[1] These levels will vary according to topography, wind, and vegetation in the area.

--The applicant could paint structures relating to the project to blend with the natural environment.

--If the noise levels are determined to be a nuisance to local residents, the Department of State Lands could, for example, require the applicant to reduce the noise by increasing building insulation or limiting operating hours. All mining-related equipment would be properly maintained to minimize noise.

CHAPTER IV: ACCESS ROAD ALTERNATIVES

The Montana Department of State Lands and the U.S. Forest Service have analyzed alternatives to various parts of the applicant's proposal. The agencies have found one county road alternative and one mine access road alternative to be acceptable. These alternatives are compared to the proposal below.

County Road

The applicant proposes to use the existing Jardine (county) Road as the access from Gardiner to the project facilities at Jardine (see figure I-3). This road would route project traffic through the residential and business areas in Gardiner and up Z-Hill, then along high, open benchland north and east of Gardiner. The applicant proposes to improve the county road by adding guard rails, widening narrow stretches, and posting game crossing and reduced speed limit signs.

The most significant disadvantage of the applicant's proposal is the increased traffic through residential areas of Gardiner and Jardine and the potential hazard to people in those areas. Mine-related traffic would also reduce ambient air quality due to increased dust levels. Noise levels would rise as well.

Increased traffic on the Z-Hill portion of the county road would increase hazards and inconvenience, especially during periods of intense recreational use, such as during the fall hunt, and during the late-season hunt in December (see Chapter II--Transportation and Recreation sections).

A mandatory bussing system, however, would avoid many of the adverse effects related to project use of the existing road. Such a system would include:

1) establishing a parking area on the outskirts of Gardiner where employees would leave their vehicles while on shift,

2) providing a bus or van to drive employees from the parking area to the project site and back again, and

3) disallowing private vehicles at the mine site.

These measures would reduce potential for accidents in residential areas, increased noise levels and dust emissions, and inconvenience to local residents and businesses.

Alternative A to the existing county road (see figure I-3) would begin near the airport and gradually climb the steep hillside north of Gardiner until it connected with the county road above Z-Hill. This alternative would route project traffic around Gardiner, reducing noise, traffic-caused dust, hazards from accidents in residential areas and on Z-Hill, and conflicts with recreational vehicles.

Either Alternative A or the applicant's proposal with the stipulation of bussing employees between Gardiner and the project site is preferred to the applicant's proposal without stipulations.

Mine Access Road

The applicant's proposed mine access road would cross Bear Creek downstream from the present bridge, requiring construction of a new bridge (see figure I-2). This road would force the removal of structures 62, 63, 64, 65, and 68 in the Jardine Historic District (see figure II-28). Four of these are considered contributing structures with the historic district.

Alternative 1 to the mine access road (see figure I-2) would avoid the Jardine Historic District; therefore, no structures within the historic district would be affected. Traffic would also be routed around the town of Jardine and the mine facilities if this alternative were chosen. A new bridge would be built across Bear Creek downstream from Jardine to accommodate Alternative 1.

The regulating agencies prefer Alternative 1 to the proposal. Alternative 1 would avoid the town of Jardine, and therefore, the Jardine Historic District. This area is considered eligible for the National Register of Historic Places (see Chapter II--Cultural Resources).

CHAPTER V: DENIAL OF THE PERMIT

Chapter III describes the impacts of approving the application as proposed with mitigating measures. This chapter analyzes the effects if DSL were to deny the permit, which it may do if the mining or reclamation plans violate the laws administered by DSL or the water and air quality laws administered by the Department of Health and Environmental Sciences.

If DSL were to deny the permit, the scenario described in Chapter II: The Existing Environment would continue unchanged. However, denial of the permit would not necessarily preclude future applications for mining or development in the Jardine area. The effects of a permit denial are listed below.

Effects to the Physical Environment

As a result of permit denial, the water quality and quantity in Bear Creek would remain unchanged, and the geology, soils, and vegetation of the area would remain undisturbed. The proposed depletion of water from Bear Creek would be avoided; this water could be used to maintain minimum instream flows during periods of short supply. Sediment loading to Bear Creek resulting from earth moving and project construction would not occur. Soil erosion predicted on waste rock dump slopes would not occur. Problems normally confronted during revegetation (introduction of weeds, for example) would be avoided because revegetation would not be necessary. The topography and scenery would continue to look as it does today.

Wildlife habitat would remain in its present condition. Current rates of poaching, antler collecting, and road-killed wildlife would not change. There would be 150 fewer people in the project area; therefore, encounters and conflicts between people and grizzly bears would occur at their current pace.

If the permit were denied, 26 acres of previously disturbed vegetation and wildlife habitat would not be reclaimed. Existing tailings in the area would also remain. Revegetation of these tailings would not occur without the project. Therefore, dust emissions from these tailings would continue about the same as today; the wind occasionally blows the tailings into plumes that sweep the area. Because the two existing tailings dumps would not be relocated, loading of arsenic and heavy metals to Bear Creek would continue at present levels.

Effects to the Economic and Social Environment

Denial of the permit would have an enormous effect on the project area economy. Area residents would lose the potential for 172 to 185 new jobs. Park County would not receive the estimated $4 million in annual income during the life of the mine. Park County and both Gardiner school districts would not collect the potential $2.6 million that the project would add to the annual tax base. Montana would not be able to collect $301,570 annually in estimated taxes from the mining project.

Gardiner and Jardine residents would probably not experience an increase in social pressure that could otherwise result from new workers and their families moving into the area. In addition, less stress would be imposed on housing and community services. Social conflict regarding the project would end. Nineteen acres would remain in agricultural use or other uses instead of being converted to residential uses. Average daily traffic trends would continue at current levels. The estimated 114 accidents on U.S. 89 caused by project-related traffic would not occur; both U.S. 89 and the Jardine Road would have less traffic congestion without the mining project. However, without the project, the Jardine Road would probably not be improved in the forseeable future.

The Jardine Historical District would remain in its present condition; 21 structures would remain undisturbed. These include three "significant" historic buildings.

CHAPTER VI: RESOURCE COMMITMENTS AND LAND USES

--The Jardine Joint Venture project would remove about 750,000 ounces of gold. Some ore would not be mined due to its low grade and the limits of available mining technology. The mine would provide tax revenues to Park County, the state of Montana, and several Gardiner-area jurisdictions.

--Some agricultural land would be converted to residential uses. Up to 19 acres of agricultural land could be permanently removed from production. Mill waste tailings, over thousands of years, could be introduced into Bear Creek due to erosion. However, the applicant proposes to clean up potential pollution sources that would degrade water quality and aquatic life in Bear Creek. This action would be considered an overriding positive benefit (see Chapter III--Geology).

--Long-term reductions in soil quality would be minimal or negligible. Over the next 20 years, about half of the soils that would be disturbed would deteriorate in quality due to prolonged storage. After reclamation, soil quality would improve with time and eventually reach premining levels.

--During the 20-year life of the mine, a pipeline break or a spill could contaminate the ground or surface water resources in the Bear Creek Basin. However, the impact on the environment would be temporary. Reclamation of the two existing tailings ponds would enhance existing ground and surface water quality. Total suspended sediment would increase by 3 percent over baseline. Cumulative impacts from mining and clearcutting would result in an increase in total suspended sediment of 9 percent over baseline.

--Irretrievable commitments of water resources would include a depletion from Bear Creek of 0.033 to 0.073 cubic feet per second as well as an increase in total suspended sediment between 6 percent and 485 percent over baseline during the first three years of development.

--Proposed revegetation would reduce forested land by 15 acres. Reestablished forests would also contain smaller trees than the premining forests. As time passes, planted and invading trees would reach premining heights and forest acreage would increase. Total plant production would increase while, in some area, diversity would decline. Both production and diversity would eventually approach premining levels.

--While the mine operates, habitat loss and mining activity would displace wildlife (including threatened and endangered species) from the permit area and adjacent habitats. Wildlife may eventually become accustomed to mining activities and use habitats near the disturbance area. After the mine closes, revegetation would allow wildlife to return to the area. However, years would be required to return browse and cover species to levels provided by premining, native habitats. Indirect impacts (such as increased recreation, poaching, and road kills) would decline over the long term if mine closure decreases the local population. Habitat losses due to logging would slowly be remedied by natural revegetation.

--Traffic increases due to the mine would contribute to 114 additional accidents and an unknown number of fatalities on U.S. 89 between Livingston and Gardiner. Traffic increases could also cause more accidents and traffic fatalities on the Jardine Road.

--The action proposed by the applicant would alter the nature of social and economic life in Gardiner and Park County. Some residents would view the changes as beneficial; others would view them as decreasing well-being.

--The proposed project would change the character of social and economic life in Gardiner through the introduction of new people to the region and through its stimulus to commerce.

--Those individuals who have chosen to reside in the Gardiner area to escape urban life and enjoy Gardiner's relative isolation may be concerned that mine development would restore what they sought to leave. Gardiner would, however, continue to be a small town whose natural and social amenities remain intact.

--Depending on the mine access road alternative used in the project, the Jardine Historic District could be affected. Five structures within the historic district would be removed if the applicant's proposed road is chosen; three of these structures are considered significant. All new mining facilities would border or occupy the historic district. These new facilities would be removed and the area would be revegetated at the end of the project.

CHAPTER VII: APPENDIXES

Appendix 1

Distribution of Macroinvertebrate Taxa and Relative Abundance in Bear Creek, 1981

Station Location	001 Bear Creek downstream Darrock Creek	002 Pine Creek at confluence Bear Creek	004 NF Bear Creek upstream Bear Creek	008 Bear Creek at Jardine bridge	009 Bear Creek upstream Pole Creek	010 Bear Creek upstream Palmer Creek	006 Bear Creek at confluence
Plecoptera							
Doroneunia theodora	X C	X C	X C	X C	X C	X C	X C
Magarcys sp.	X C	X C	X C	X C	X C	X C	X C
Cultus sp.	X U	X U	X U		X U		
Yaroperla brevis	X R	X R	X R				X R
Nemoura arctica	X R						
Prostoia besametsa	X R		X R				
Visoka cataractae			X R				
Zapada oregonesis (group)	X U	X U	X U	X U		X U	
Zapada frigida	X R						
Zapada cinctipes	X C	X C	X C	X C	X C	X C	X C
Zapada columbiana	X U	X U	X U	X U	X U	X C	X C
Chloroperlidae	X A	X A	X A	X A	X A	X A	X A
Capniidae	X C	X C	X C	X C	X C	X C	X C
Ephemeroptera							
Cinygmula sp.	X U	X U	X U	X U	X C	X C	X C
Rhithrogena robusta	X A	X A	X A	X A	X A	X A	X A
Rhithrogena sp.	X U	X U	X U	X U	X U	X U	X U
Epheorus grandis	X C	X C	X C	X C	X C	X C	X C
Epheorus, Iran sp.	X U	X U	X U	X U	X U	X U	X U
Ameletus sp.	X C	X C	X C	X C	X C	X C	X C
Baetis bicaudatus	X C	X C	X C	X C	X C	X C	X C
Baetis intermedius	X C	X C	X C	X C	X C	X C	X C
Baetis sp.	X U	X U	X U	X U	X U	X U	X U
Pseudocloeon sp.			X U		X U		
Ephemerella grandis ingens							X R
Ephemerella doddsi	X C	X C	X C	X C	X C	X C	X C
Ephemerella hystrix	X U	X U	X U		X U		
Ephemerella coloradensis			X U	X U			X U
Ephemerella spinifera	X U		X U	X U	X U		X U
Ephemerella infrequens							X R
Ephemerella teresa	X R						
Ephemerella tibialis				X U		X U	

Appendix 1 (continued)

Station Location	001 Bear Creek downstream Darrock Creek	002 Pine Creek at confluence Bear Creek	004 NF Bear Creek upstream Bear Creek	008 Bear Creek at Jardine Bridge	009 Bear Creek upstream Pole Creek	010 Bear Creek upstream Palmer Creek	006 Bear Creek at confluence
Trichoptera							
Parapsyche sp.	X C	X C	X C	X C	X C	X C	X C
Rhyacophila sp. (4)	X C	X C	X C	X C	X C	X C	X C
Glossosoma sp.	X U			X U		X U	
Micrasema sp.							X U
Chryanda centralis				X R			
Ecclisomyia bilera	X U	X U	X U	X U	X U	X U	X U
Rossiana montana	X C	X C	X C	X C	X C	X C	X C
Cryptochia sp.			X R				
Apatania sp.			X U	X U			
Neothremma sp.			X R				
Eccliscosmoecus scylla				X R		X R	
Limnephilus sp.						X R	X R
Coleoptera							
Heterlimnius sp.	X R		X R			X R	
Amphizoa sp.					X R		
Diptera							
Hexatoma sp.	X U	X U	X U	X U	X U	X U	X U
Dicranota sp.	X C	X C	X C	X C	X C	X C	X C
Tipula sp.				X R	X R	X R	
Antocha sp.						X R	
Blephariceridae	X U		X U				X U
Simulidae	X U		X U	X U	X U	X U	X U
Ceratopogonidae				X R			
Empididae	X U	X U	X U	X U	X U	X U	X U
Chironomidae	X C	X C	X C	X C	X C	X C	X C
Other							
Hirudinea	X C	X C	X C	X C	X C	X C	X C
Total Taxa	38	29	41	35	32	34	34

[a] Four individual species recognized (3 of common occurrence and 1 uncommon to rare)

X indicates presence of taxa

R = rare, U = uncommon, C = common, A = abundant

Appendix 2

Birds Recorded Along Survey Transects
May-July, 1981-1982

Common name	Scientific name
American robin	*Turdus migratorius*
Black-billed magpie	*Pica pica*
Brewer's blackbird	*Euphagus cynocephalus*
Cassin's finch	*Carpodacus cassinii*
Chipping sparrow	*Spizella passerina*
Clark's nutcracker	*Nucifraga columbiana*
Common flicker	*Colaptes* sp.
Common raven	*Corvus corax*
Common yellowthroat	*Geothlypis trichas*
Downy woodpecker	*Dendrocopos pubescens*
Flycatcher	*Empidonax* sp.
Gray jay	*Perisoreus canadensis*
Gray-crowned rosy finch	*Leucosticte tephrocotis*
Hermit thrush	*Hylocichla guttata*
House wren	*Troglodytes aedon*
Lark sparrow	*Chondestes grammacus*
Lazuli bunting	*Passerina amoena*
Mourning dove	*Zenaida macroura*
Mountain bluebird	*Sialia currucoides*
Mountain chickadee	*Parus gambeli*
Ovenbird	*Seiurus aurocapillus*
Pine grosbeak	*Pinicola enucleator*
Pine siskin	*Spinus pinus*
Red crossbill	*Loxia curvirostra*
Red-breasted nuthatch	*Sitta canadensis*
Red-eyed vireo	*Vireo olivaceus*
Rock wren	*Salpinctes obsoletus*
Ruby-crowned kinglet	*Regulus calendula*
Savannah sparrow	*Passerculus sandwichensis*
Starling	*Sturnus vulgaris*
Stellar's jay	*Cyanocitta stelleri*
Townsend's solitaire	*Myadestes townsendii*
Tree swallow	*Iridoprocne bicolor*
Vesper sparrow	*Pooecetes gramineus*
Violet-green swallow	*Tachycineta thalassina*
Warbling vireo	*Vireo gilvus*
Western meadowlark	*Sturnella neglecta*
Western tanager	*Piranga ludoviciana*
White-crowned sparrow	*Zonotrichia leucophrys*
White-throated swift	*Aeronautes saxatalis*
White-throated sparrow	*Zontrichia albicollis*
Williamson's sapsucker	*Sphyrapicus thyroideus*
Yellow-rumped warbler	*Dendroica* sp.

Appendix 3

Scientific Names of Wildlife Species

Common name	Scientific name
Mammals	
Bighorn sheep	Ovis canadensis
Bison	Bison bison
Black bear	Ursus americanus
Bobcat	Lynx rufus
Caribou	Rangifer tarandus
Columbian ground squirrel	Spermophilus columbianus
Common shrew	Sorex cinerus
Coyote	Canis latrans
Deer mouse	Peromyscus maniculatus
Elk	Cervus elaphus
Gray wolf	Canis lupus
Grizzly bear	Ursus arctos
Marten	Martes americana
Meadow vole	Microtus pennsylvanicus
Moose	Alces alces
Mountain cottontail	Sylvilagus nuttalli
Mountain lion	Felis concolor
Mule deer	Odocoileus hemionus
Northern flying squirrel	Glaucomys sabrinus
Porcupine	Erethizon dorsatum
Red fox	Vulpes fulva
Red squirrel	Tamiasciurus hudsonicus
Red-backed vole	Clethrionomys gapperi
Snowshoe hare	Lepus americanus
Weasel	Mustela sp.
Western jumping mouse	Zapus princeps
White-tailed jackrabbit	Lepus townsendii
Yellow pine chipmunk	Eutamias amoenus
Yellow-bellied marmot	Marmota flaviventris
Birds	
American kestrel	Falco sparverius
Bald eagle	Haliaeetus leucocephalus
Blue grouse	Dendragapus obscurus
Blue-winged teal	Anas discors
Chipping sparrow	Spizella passerina
Common merganser	Mergus merganser
Dark-eyed junco	Junco hyemalis
Gadwall	Anas strepera
Golden eagle	Aquila chrysaetos
Goshawk	Accipiter cooperii
Great horned owl	Bubo virginianus
Green-winged teal	Anas carolinensis
Long-eared owl	Asio otus
Mallard	Anas platyrhynchos

Appendix 3 (continued)

Common name	Scientific name
Birds (continued)	
Merlin	*Falco columbarius*
Mountain chickadee	*Parus gambeli*
Northern harrier	*Circus cyaneus*
Osprey	*Pandion haliaetus*
Peregrine falcon	*Falco peregrinus*
Pintail	*Anas acuta*
Prairie falcon	*Falco mexicanus*
Red-tailed hawk	*Buteo jamaicensis*
Robin	*Turdus migratorius*
Ruffed grouse	*Bonasa umbellus*
Sharp-shinned hawk	*Accipiter striatus*
Short-eared owl	*Asio flammeus*
Swainson's hawk	*Buteo swainsoni*
Reptiles and Amphibians	
Garter snake	*Thamnophis* sp.
Prairie rattlesnake	*Crotalus viridis*
Racer	*Coluber* sp.
Spotted frog	*Rana pretiosa*

Appendix 4

Scientific Names of Plant Species

Common name	Scientific name
Grasses	
Beardless wheatgrass	Agropyron inerme
Blue wildrye	Elymus glaucus
Bluebunch wheatgrass	Agropyron spicatum
Canada bluegrass	Poa compressa
Columbia needlegrass	Stipa occidentalis
Elk sedge	Carex geyeri
Fowl bluegrass	Poa palustris
Green needlegrass	Stipa viridula
Hard fescue	Festuca ovina
Idaho fescue	Festuca idahoensis
Indian ricegrass	Oryzopsis hymenoides
Kentucky bluegrass	Poa pratensis
Meadow foxtail	Alopecurus pratensis
Mountain brome	Bromus marginatus
Pinegrass	Calamagrostis rubescens
Prairie junegrass	Koeleria cristata
Slender wheatgrass	Agropyron trachycaulum
Smooth brome	Bromus inermis
Timothy	Phleum sp.
Western wheatgrass	Agropyron smithii
Forbs	
Alsike clover	Trifolium hydridum
Arrowleaf balsamroot	Balsamorhiza sagittata
Clover	Trifolium sp.
Common horsetail	Equisetum sp.
Cow parsnip	Heracleum lanatum
Fireweed	Epilobium angustifolium
Heartleaf arnica	Arnica cordifolia
Many-flowered phlox	Phlox multiflora
Rocky mountain helianthella	Helianthella uniflora
Rose pussytoes	Antennaria sp.
Showy aster	Aster conspicuus
Silky lupine	Lupinus sericeus
Starry Solomon's seal	Smilacina stellata
Sticky geranium	Geranium viscosissimum
Sulfur buckwheat	Eriogonum umbellatum
Sweetscented bedstraw	Galium triflorum
Thickstem aster	Aster integrifolius
Twinflower	Linnaea borealis
Weedy milkvetch	Astragalus miser
Western meadowrue	Thalictrum occidentale
Yarrow	Achillea millefolium
Shrubs	
Big sagebrush	Artemisia tridentata
Blue huckleberry	Vaccinium globulare
Common snowberry	Symphoricarpos albus
Gooseberry	Ribes sp.
Green rabbitbrush	Chrysothamnus viscidiflorus
Honeysuckle	Lonicera utahensis

Appendix 4 (continued)

Common name	Scientific name
Shrubs (continued)	
Prickly rose	Rosa acicularis
Rocky mountain juniper	Juniperus scopulorum
Serviceberry	Amelanchier sp.
Shiny-leaf spirea	Spiraea betulifolia
Smooth currant	Ribes inerme
Thimbleberry	Rubus parviflorus
Wood's rose	Rosa woodsii
Trees	
Douglas-fir	Pseudotsuga menziesii
Engelmann spruce	Picea engelmannii
Lodgepole pine	Pinus contorta
Quaking aspen	Populus tremuloides
Subalpine fir	Abies lasiocarpa
Whitebark pine	Pinus albicaulis

Appendix 5

Bedrock Motion Data for the Jardine Area
Recurrence Times etc. for Bedrock Motion at Jardine

	Modified Mercalli Intensity					
	V	VI	VII	VIII	IX	X
Recurrence time (years)	22	50	196	869	7,147	73,405
Peak horizontal acceleration (g)	0.03	0.06	0.12	0.25	0.50	0.99
Peak horizontal velocity (cm/sec)	4.2	7.4	13.2	23.4	41.6	74.1
Peak horizontal displacement (cm)	2.6	4.1	6.3	9.8	15.1	23.4
Duration of shaking (sec)	24.8	18.1	15.3	14.4	19.1	31.5

Surface Material Motion Data for Jardine

	Modified Mercalli Intensity					
	V	VI	VII	VIII	IX	X
Recurrence time (years)	22	50	196	869	7,147	73,405
Peak horizontal acceleration (g)	0.05	0.07	0.11	0.19	0.33	0.65
Peak horizontal velocity (cm/sec)	6.1	8.1	11.9	18.6	29.7	52.2
Peak horizontal displacement (cm)	3.5	4.4	5.8	8.2	11.7	18.0
Duration of shaking (sec) Table 1.C.4	34.8	28.1	25.3	24.4	29.1	42.5

Source: Jardine Joint Venture Application, 1984, p. 1-C-39 and p. 1-C-44.

Appendix 5 (continued)

Modified Mercalli Intensity Scale of 1931 (abridged)

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize the motion as an earthquake. Standing motor cars may rock slightly. Vibration similar to that of a passing truck.

IV. During the day, felt indoors by many; felt outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation similar to that of a heavy truck striking building. Standing motor cars rock noticeably.

V. Felt by nearly everyone; many awakened. Some dishes and windows broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes notices. Pendulum clocks may stop.

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of falling plaster or damaged chimneys. Damage slight.

VII. Everyone moves outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built, ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motor cars.

VIII. Damage slight in specially designed structures; considerable in ordinary, substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Destruction of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected from ground in small amounts. Changes in well water. Persons driving motor cars disturbed.

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Ground badly cracked. Rails bent. Considerable amount of landslides from river banks and steep slopes. Shifted sand and mud. Water splashed over banks.

Appendix 6

Water Quality Standards for A-1 and B-1 Streams

ARM 16.20.617 A-1 CLASSIFICATION (1) Waters classified A-1 are suitable for drinking, culinary, and food processing purposes after conventional treatment for removal of naturally present impurities.

(2) Water quality must be suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(3) For waters classified A-1 the following specific water quality standards shall not be violated by any person:

(a) The geometric mean number of organisms in the coliform group must not exceed 50 per 100 milliliters if resulting from domestic sewage.

(b) Dissolved oxygen concentration must not be reduced below 7.0 milligrams per liter.

(c) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 must be less than 0.5 pH unit. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0.

(d) No increase above naturally occurring turbidity is allowed except as permitted in ARM 16.20.633.

(e) A 1°F maximum increase above naturally occurring water temperature is allowed within the range of 32°F to 66°F; within the naturally occurring range of 66°F to 66.5°F, no discharge is allowed which will cause the water temperature to exceed 67°F; and where the naturally occurring water temperature is 66.5°F or greater, the maximum allowable increase in water temperature is 0.5°F. A 2°F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55°F, and a 2°F maximum decrease below naturally occurring water temperature is allowed within the range of 55°F to 32°F.

(f) No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

(g) True color must not be increased more than two units above naturally occurring color.

(h) Concentrations of toxic or other deleterious substances which would remain in the water after conventional water treatment must not exceed the maximum contaminant levels set forth in the 1975 National Interim Primary Drinking Water Standards (40 CFR Part 141) or subsequent revisions or the 1979 National Secondary Drinking Water Standards (40 CFR Part 143) or subsequent revisions. The maximum allowable concentrations of toxic or deleterious substances also must not exceed acute or chronic problem levels as revealed by bioassay or other methods. The values listed in EPA Water Quality Criteria documents (Federal Register Vol. 45, No. 231, Friday, November 28, 1980, pages 79318-79379) shall be used as a guide to determine problem levels unless local conditions make these values inappropriate. In accordance with section 75-5-306(1), MCA, it is not necessary that wastes be treated to a purer condition than the natural condition of the receiving water.

Appendix 6 (continued)

(4) The board hereby adopts and incorporates by reference "EPA Water Quality Criteria documents (Federal Register Vol. 45, No. 231, Friday, November 28, 1980, pages 79318-79739)", which set forth water quality criteria for toxic or other deleterious substances. Copies of this document may be obtained from the Water Quality Bureau, Department of Health and Environmental Sciences, Cogswell Building, Capitol Station, Helena, Montana 59620. (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80; AMD, 1984 MAR p. 1802, Eff. 12/14/84.)

ARM 16.20.618 B-1 CLASSIFICATION (1) Waters classified B-1 are suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(2) For waters classified B-1 the following specific water quality standards shall not be violated by any person:

(a) During periods when the daily maximum water temperature is greater than 60°F, the geometric mean number of organisms in the fecal coliform group must not exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters.

(b) Dissolved oxygen concentration must not be reduced below 7.0 milligrams per liter.

(c) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 must be less than 0.5 pH unit. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0.

(d) The maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units except as permitted in ARM 16.20.633.

(e) A 1°F maximum increase above naturally occurring water temperature is allowed within the range of 32°F to 66°F; within the naturally occurring range of 66°F to 66.5°F, no discharge is allowed which will cause the water temperature to exceed 67°F; and where the naturally occurring water temperature is 66.5°F or greater, the maximum allowable increase in water temperature is 0.5°F. A 2°F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55°F, and a 2°F maximum decrease below naturally occurring water temperature is allowed within the range of 55°F to 32°F. This applies to all waters in the state classified B-1 except for Prickly Pear Creek from McClellan Creek to the Montana Highway No. 433 crossing where a 2°F maximum increase above naturally occurring water temperature is allowed within the range of 32°F to 65°F; within the naturally occurring range of 65°F to 66.5°F, no discharge is allowed which will cause the water temperature to exceed 67°F; and where the naturally occurring water temperature is 66.5°F or greater, the maximum allowable increase in water temperature is 0.5°F.

(f) No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

Appendix 6 (continued)

(g) True color must not be increased more than five units above naturally occurring color.

(h) Concentrations of toxic or other deleterious substances which would remain in the water after conventional water treatment must not exceed the maximum contaminant levels set forth in the 1975 National Interim Primary Drinking Water Standards (40 CFR Part 141) or subsequent revisions or the 1979 National Secondary Drinking Water Standards (40 CFR Part 143) or subsequent revisions. The maximum allowable concentrations of toxic or deleterious substances also must not exceed acute or chronic problem levels as revealed by bioassay or other methods. The values listed in EPA Water Quality Criteria documents (Federal Register Vol. 45, No. 231, Friday, November 28, 1980, pages 79318-79379) shall be used as a guide to determine problem levels unless local conditions make these values inappropriate. In accordance with section 75-5-306(1), MCA, it is not necessary that wastes be treated to a purer condition than the natural condition of the receiving water.

(3) The board hereby adopts and incorporates by reference "EPA Water Quality Criteria documents (Federal Register Vol. 45, No. 231, Friday, November 28, 1980, pages 79318-79379)", which set forth water quality criteria for toxic or other deleterious substances. Copies of this document may be obtained from the Water Quality Bureau, Department of Health and Environmental Sciencies, Cogswell Building, Capitol Station, Helena, Montana 59620. (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80; AMD, 1982 MAR p. 1746, Eff. 10/1/82; AMD, 1984 MAR p. 1802, Eff. 12/14/84.)

Appendix 7

Description of Reagents Used in Ore Beneficiation

Five different reagents would be used in the ore beneficiation process. These include sodium cyanide, Aerofloat 208, Aero 350 Xanthate, Aerofroth 76, and Separan NP10. Table III-3 presents the application rate of each reagents, based on a production rate of 750 tons of ore per day. Mill circuit waste water would be expected to contain concentrations of these reagents in different chemical compositions. These wastes would be moved to the lined tailings dump or would be backfilled in the mine stopes. This appendix will describe both the physical characteristics and toxicity of each reagent used in the ore beneficiation process.

Sodium Cyanide

Sodium cyanide is a simple alkali metal salt which dissociates in aqueous solution. Upon dissociation, the cyanide ion combines with a hydrogen ion to form hydrocyanic acid (HCN) (Dupont, no date). Although highly toxic to aquatic life, HCN occurs only rarely in nature due to the reactivity of the molecule. In the environment, cyanides are connected to other compounds, or they form complexes with trace metals. The stability of metallocyanide complexes is highly variable. For example, complexes formed with zinc and cadmium are unstable, while those formed with cobalt and iron are very stable. The iron cyanides however, dissociate to release toxic cyanide ions in the presence of sunlight. Photo-chemical degradation of ferrocyanide and ferric cyanide is considered the major environmental concern regarding persistence of cyanide in the environment.

Aquatics. Almost all aquatic toxicological studies have been directed toward measuring the effect of free cyanides on aquatic organisms. Little information has been developed discussing the fate of cyanides, cyano complexes, and cyanates in the environment.

Human Responses. The following inhalation toxicity data are estimated human responses to various concentrations of HCN (National Institute of Occupational Safety and Health, 1976):

330 ppm.......Rapidly fatal if no emergency aid is administered
100-200 ppm ......Fatal within 1/2 to 1 hour
45-54 ppm.......Tolerated for 1/2 to 1 hour without immediate or delayed effects
20-40 ppm.......Slight symptoms after several hours
10 ppm.......Threshold limit/time-weighted average for a normal 8-hour workday
2-5 ppm.......Odor threshold

Cyanide ingested by humans at quantities of 10 milligrams or less per day is not toxic and is biotransformed to the less-toxic thiocyanate. Continuous long-term consumption of up to 5 milligrams per day has shown no injurious effects. Lethal toxic effects from the ingestion of water containing cyanide occur only when cyanide concentrations are high and overwhelm the detoxifying mechanisms of the human body (Environmental Protection Agency, 1976).

Appendix 7 (continued)

Fisheries. A review of available data on acute toxicity of simple cyanides to fish reveals the following minimum lethal concentrations:

Brook Trout -- 0.05 mg/l
Rainbow Trout -- 0.07 mg/l
Brown Trout -- 0.07 mg/l

The Environmental Protection Agency (EPA) has concluded that free cyanide concentrations in the range of 0.05 to 0.10 mg/l as cyanide have proven eventually fatal to many sensitive fishes. Levels above 0.20 mg/l are probably rapidly fatal to most fish species. (Environmental Protection Agency, 1976)

Although HCN is the most toxic form of cyanide in water, the ratio of HCN to total cyanide is variable and depends on pH, temperature, soils, natural oxidants, bacteria, and photochemical actions. For these reasons, the EPA cyanide criteria of 0.005 mg/l is based on the concentration of total cyanide.

A workshop sponsored by the National Science Foundation suggests that further research needs to be completed regarding the fate and toxicity of cyanide in the environment (National Science Foundation, 1983).

Aerofloat 208

Aerofloat 208 is a phosphorodithioate salt used in mineral separation during the ore beneficiation process.

The acute oral LD_{50} (lethal dose for 50% of the exposed group) for rats is 8.46 grams per kilogram of body weight. Marked eye irritation and skin corrosion were produced during primary irritation studies with rabbits.

Engineering controls are not needed to protect workers from exposure if good hygiene practices are strictly followed.

Aero 350 Xanthate

Aero 350 Xanthate is an alkylxanthate salt used as a reagent in the ore beneficiation process. The acute oral LD_{50} for rats is between 1.0 and 2.0 grams per kilogram of body weight. Airborne dust may cause significant eye and skin irritations or irritation of the respiratory tract.

Aero 350 xanthate should be used in a closed-ventilation system. Where engineering controls are effective, respiratory protection is generally not required. Aero 350 Xanthate must be stored in a cool, dry, well-ventilated area.

Appendix 7 (continued)

Aerofroth 76

Aerofroth 76 is classified as an alcohol. It is used as a reagent in the ore beneficiation process. The acute oral LD_{50} for rats is 3.2 grams per kilogram of body weight.

Aerofroth 76 is a combustible liquid that would be harmful if inhaled and that would cause eye and skin irritation. Good enclosure and local exhaust ventilation should be provided to minimize exposure.

Separan NP10

Separan NP10 is a hydrolyzed polyacrylamide that appears as a white, free flowing, amorphous solid with little odor. The acute oral LD_{50} is 2 grams per kilogram of body weight.

Separan NP10 could cause slight transient eye irritation. Reasonable caution and personal cleanliness should be taken in handling and storage.

Appendix 8
Plant Species Important to Grizzly Bears

Scientific names	Common names
Shrubs	
Arctostaphylos uva-ursi	Kinnikinnick
Crateagus douglasii	Black hawthorn
Rhamnus alnifolia	Alderleaf buckthorn
Ribes spp.	Currant
Sheperdia canadensis*	Buffaloberry
Vaccinium caespitosum	Dwarf huckleberry
V. globulare*	Blue huckleberry
V. scoparium*	Grouse whortleberry
Forbs	
Cirsium arvense	Canada thistle
C. foliosum	Elk thistle
Claytonia lanceolata*	Lanceleaf springbeauty
Epilobium angustifolium*	Fireweed
Robust Epilobium spp. (e.g. E. glandulosum)	Fireweed
Equisetum arvense*	Horsetail
Equisetum spp.	Horsetail
Fragaria vesca	Woodland strawberry
F. virginiana*	Strawberry
Heracleum lanatum	Cowparsnip
Lomatium foeniculaceum*	Biscuitroot
L. dissectum	Desert parsley
L. triternatum	Nineleaf lomatium
Perideridia gairdneri*	Yampa
Polygonum bistortoides*	American bistort
Robust Polygonum spp. (e.g. P. amphibium)	Knotweed
Potamogeton spp. (P. natans, alpinus, etc.)	Pondweed
Streptopus amplexifolius	Twistedstalk
Taraxacum spp. (T. officinale, ceratophorum, etc.)*	Dandelion
Trifolium hybridum*	Alsike clover
T. longipes*	Longstalk clover
T. repens*	White clover
Graminoids	
Agropyron spp.	Wheatgrasses
Bromus spp.	Brome grasses
Calamagrostis spp.*	Pinegrass, reedgrass
Carex spp.*	Sedges
Deschampsia spp.*	Hairgrasses
Festuca spp.	Fescues
Melica spp.*	Oniongrasses
Phleum spp.*	Timothy
Poa spp.*	Bluegrasses
Scirpus spp.	Bulrushes

*Food items especially well-represented in the diet.

Appendix 9

Trail Data in the Jardine Area

Name	Use Level[1]	Period
LaDuke Trail	H L	10/15 - 11/30 12/1 - 10/14
Little Trail Creek & Maiden Basin	H L	10/15 - 11/30 12/1 - 10/14
North Fork Bear Creek	H L	10/15 - 11/30 12/1 10/14
Bear Creek Trail (Jardine to Darroch Creek)	H L	10/15 - 11/30 12/1 - 10/14
Bear Creek Trail (Darroch to Castle Lake)	H L	7/1 - 9/30 10/1 - 6/30
Bear Creek Trail (Castle Lake to Monitor Park)	L	Year round
Bear Creek Trail (Caste Lake Junction to Horse Creek)	H L	7/1 - 9/30 10/1 - 6/30
Jardine/Hellroaring Trail (High and low routes)	H L	7/15 - 10/15 10/16 - 7/14
Palmer Mountain Trail	H L	7/1 - 11/30 12/1 - 6/30
Crevice Trail (Park Line Trail)	H L	10/15 - 11/30 12/1 - 10/14

Source: Tom Puchlerz, Wildlife Biologist, U.S. Forest Service, Gallatin National Forest.

[1]H = High, L = Low

Appendix 9 (continued)

Road Data Jardine CEA

Name	Use Level	Period
Little Trail Creek Road	H L	10/15 - 2/15 2/16 - 10/14
C. Haye Residential Road	H	Year round
Eagle Creek Road (To Pole Creek Road)	H Closed	6/1 - 11/30 12/1 - 5/30
Pole Creek Road	L Closed	7/1 - 9/30 10/1 - 6/30
Eagle Creek System Above Pole Creek	L Closed	6/1 - 10/15 10/16 - 5/30
Gardiner/Jardine County Road	H	Year round
Bear Creek Road	H Closed	6/1 - 11/30 12/1 - 5/30
Darroch Creek System Ash Mountain System	L H Closed	6/1 - 10/15 10/16 - 11/30 12/1 - 5/30
Bear Fork Road System	L H Closed	6/1 - 10/15 10/16 - 11/30 12/1 - 5/30
Bald Mountain Road	L H Closed	6/1 - 10/15 10/16 - 11/30 12/1 - 5/30
Jardine Mining Roads (Private)	H	Year round

CHAPTER VIII: REFERENCES CITED

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CHAPTER IX: CONSULTATION AND COORDINATION

RESEARCH AND WRITING

The following people prepared the EIS:

Carole Armstrong, Office Manager

Dan Ashenberg, Hydrologist
- B.S. Biology, Tulane University, 1975
- M.S. Water Resources Management, University of Wisconsin, 1982

Chuck Baer, Graphic Artist
- B.A. Art Education, Montana State University, 1970

John Herrin, Geologist
- B.S. Earth Science, California State University, Long Beach, 1974
- B.S. Geology, Northern Arizona University, 1975

Jerry T. Light, Wildlife Biologist, USDA Forest Service
- B.S. Forestry, University of Idaho, 1957

Ross MacPherson, Forester, USDA Forest Service
- B.S. Syracuse University, 1960

Scott McCollough, Wildlife Biologist
- B.S. Wildlife Biology, Colorado State University, 1977
- M.S. Wildlife Biology, Colorado State University, 1982

Bill Olsen, Air Quality Specialist
- B.A. Biology, State University College of New York, 1971
- Ph.D. Botany, University of Montana, 1983

Sharleen Pendergrass, Editor
- B.A. English, University of Montana, 1984

Sherm Sollid, Geologist, USDA Forest Service
- B.S. Geology, Montana State University, 1969
- M.S. Geology, Montana State University, 1973

Scott Spano, Soil Scientist
- B.S. Forestry, Michigan Technological University, 1976
- M.S. Forest Soils, Michigan Technological University, 1978

Lois Steinbeck, Economist
- B.S. Economics, Colorado State University, 1977

Kit Walther, Project Chief

- B.S. Zoology, University of Montana, 1966
- M.S.T. Biological Sciences, University of Montana, 1971

REVIEW

The following people from the Department of State Lands reviewed this document:

Gary Amestoy, Reclamation Division Administrator
Chuck Baltzer, Geologist
Ed Gensler, Geologist
Terry Grotbo, Hard Rock Bureau Chief
Gary Lynch, Range Scientist
John North, Legal Counsel
P. Dennis Smith, Hydrologist

The following people from the USDA Forest Service reviewed this document:

Mike Burnside, Geologist
Ron Escano, Wildlife Biologist
Steve Glasser, Hydrologist
Ed Heist, Land Management Planner
Rich Inman, Range Conservationist
Jerry Light, Wildlife Biologist
Jim Lloyd, Fisheries Biologist
Ross MacPherson, Forester
Susan Marsh, Landscape Architect
Doug McClelland, Civil Engineer
Tom Puchlerz, Wildlife Biologist
Mike Ryan, Archaeologist
John Sandmeyer, Land Management Planner
Henry Shovic, Soil Scientist
Sherm Sollid, Geologist
Norm Yogerst, Soil Scientist
Roger White, Civil Engineer

PEOPLE, AGENCIES, AND COMPANIES CONSULTED

The following people and companies (other than those cited in the text) provided information used to analyze the Jardine Joint Venture project:

Montana State Board of Education, Helena (State Historic Preservation Program)

Montana Department of Administration, Research and Statistical Services (Helena)

Montana Department of Commerce, Economic and Community Development Division (Helena)

Montana Department of Commerce, Hard Rock Mining Assistance Board (Helena)

Montana Department of Fish, Wildlife and Parks (Helena)

Montana Department of Health and Environmental Sciences, Air Quality Bureau and Water Quality Bureau (Helena)

Montana Department of Justice, Highway Traffic Safety Section (Helena)

Montana Department of Highways, Planning and Research Bureau (Helena)

Montana Power Company

Park County Planning Office (Livingston)

U.S. Army Corps of Engineers

REVIEW OF THIS STATEMENT

In accordance with environmental law, copies of the draft EIS have been sent to the public for comments and suggestions. All comments will be carefully considered by the agencies. Address comments on the draft EIS to Commissioner Dennis Hemmer, Montana Department of State Lands, Capitol Station, Helena, Montana 59620.

The draft EIS is available for review in the following places:

Montana Department of State Lands, 1625 11th Avenue, Helena, Montana

Gallatin National Forest, Supervisor's Office, Federal Building, Bozeman, Montana

Montana State Library, 1515 E. 6th Avenue, Helena, Montana

Park County Library, 228 W. Callender, Livingston, Montana

Gallatin National Forest Ranger Station, Gardiner, Montana

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